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March 29, 1934

Engineering News-Record

No More Unpreparedness

¶ Let us be realistic about it: The work-relief system that is to follow the CWA next week is not a short-time affair. Even with all that the PWA can do we have many months of work-relief ahead of us, and in all likelihood there will be another intensified campaign next winter.

¶ The CWA call last November came with but two weeks' notice. No plans were ready; projects, schedules and all the other necessary preliminaries were lacking. The consequence of unpreparedness was an appalling amount of waste motion, as well as a failure in morale-building that is reflected in current CWA strike movements. We are still unprepared, and now forethought must be taken to carry the campaign through the long pull.

¶ Selection and planning of work-relief projects for a year's program should begin at once. Engineering officials the country over should prepare themselves and their organizations to meet the grave responsibility of carrying on constructive jobs next winter. Let us have no more unpreparedness.

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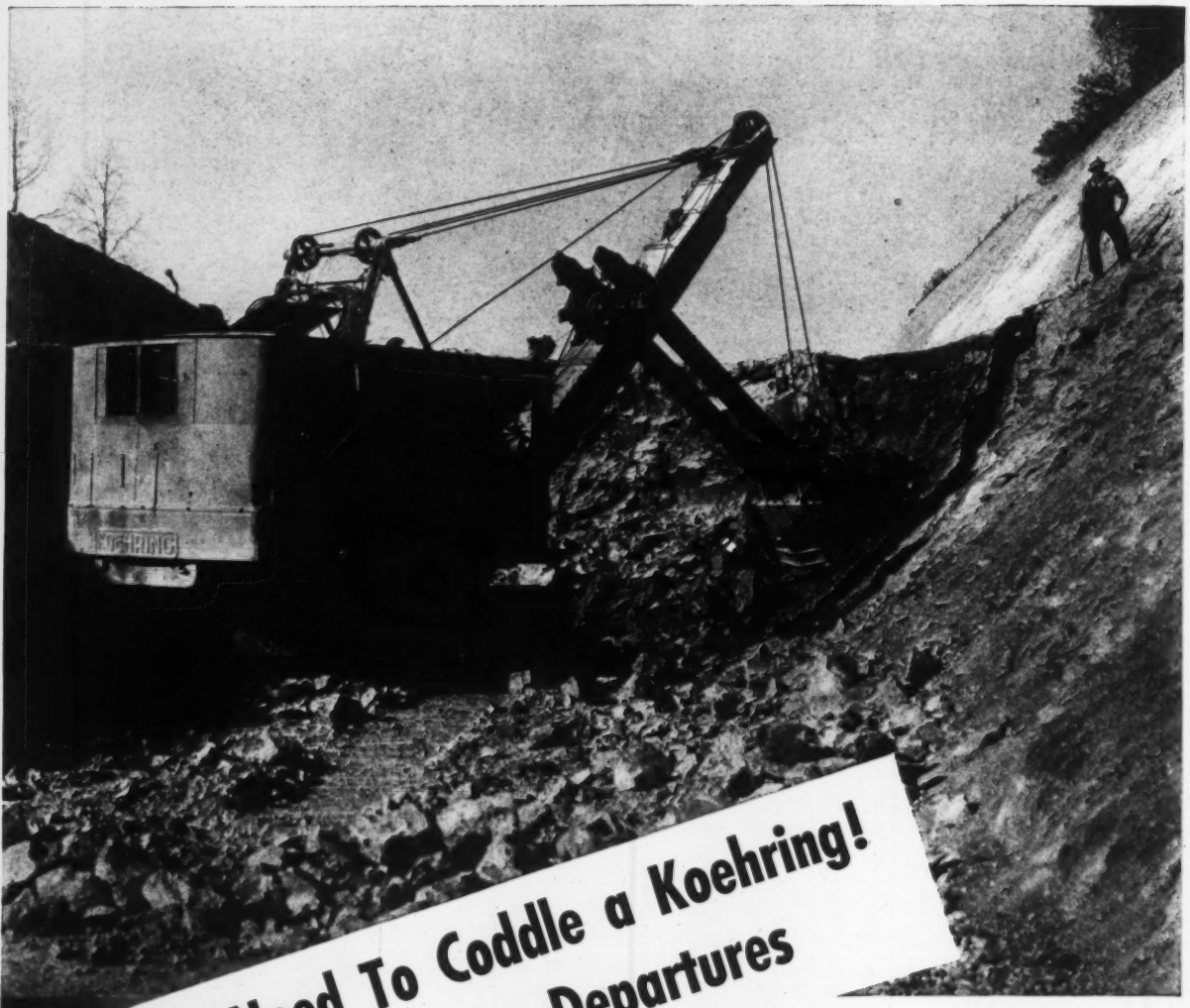

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Editorial Staff
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In the News:

LOS ANGELES VOTERS turned down a bond issue designed to provide funds for repairing the schools damaged by the 1933 earthquake and for new schools, though scores of schools are condemned as unsafe and children are attending classes in two shifts in crowded temporary quarters.

THE FORT PECK DAM PROJECT on the Missouri River in Montana is rapidly approaching active construction. Bids were opened on March 17 for a 287-mile electric transmission line from the city of Great Falls, and bids will be called on April 11 for the construction of four diversion tunnels 28 ft. in diameter and 6,000 ft. long. The dam will require upwards of 75,000,000 cu.yd. of hydraulic fill, a yardage several times greater than in any existing dam.

WHAT WILL HAPPEN to the Coast and Geodetic Survey work after the CWA ends has caused considerable concern. A meeting at the offices of the American Engineering Council in Washington on March 21 concluded that, under the new relief plan, state sanctioning of the work will be necessary. The Council proposes formation of a temporary consolidated survey and mapping authority.

"ONE REASON so many of our towns and cities are cluttered up with worn-our buildings is that our system for getting rid of useless structures has been so imperfect and unsatisfactory," said Jacob Baker, assistant administrator, Federal Emergency Relief Administration, in opening a conference on demolition at Washington on March 23. Progress was made toward a nationwide program of piecemeal slum clearance in which owners will turn their structures over to the local government for demolition.

THE LAKES-TO-GULF WATERWAY, involving the Mississippi and Illinois Rivers, was opened to navigation from New Orleans to Chicago on March 23. Peoria has been the northern terminus since March 1.

In this Issue:

THE ROLLER-GATE dam installation on the Mississippi River at Rock Island, Ill., is the largest in the world. Nine cylindrical gates, from 16 to 19 ft. in diameter and 109 ft. long, dam the entire width of the river. An article devoted to the dam structure and the methods of construction is a companion piece to the article on the Rock Island locks published two weeks ago.

THE FIRST of a series of tabulations of data on sewage-plant design and operating performance is published in this issue. The data are from Decatur, Ill. Similar tabulations to follow for other cities will afford sanitary engineers information and comparisons that heretofore have never been available.

CAREFUL DESIGN of small bridges to secure pleasing appearance is not as widely practiced as it might be. For this reason the results achieved by the Ohio state highway department on a double-leaf bascule flanked by a fixed span at either end are noteworthy. The structure, described in this issue, is distinctive for harmony between concrete and steel masses and between the outlines of fixed and movable spans. Color is used for concrete trim; welded steel floor and railing are other features.

THE FOURTH Terzaghi article deals with the effect of capillary forces on partly saturated fill. It discusses a critical factor in the strength of earth-retaining structures.

CONCRETE BRIDGE-BUILDING at below-zero temperatures is excellently typified by the Broadway Bridge at Saskatoon, Saskatchewan. The five-arch structure was built as an unemployment relief project, with outstanding success. Nearly 1,600 local men were employed during eleven months, and the bridge was built for $7.30 per sq.ft.

Coming Articles:

HOW WILL the construction code operate? How does it affect the individual contractor? What is the meaning of its various provisions? The answer to these and many other pertinent questions will be found in an extensive analysis of the code to be published in next week's issue.

INADEQUACY of the usual caisson-sinking methods for the record-size piers required in the West Channel of the San Francisco-Oakland Bridge led to the development of a new procedure. Depth to rock necessitated the open-dredging process, but the horizontal dimensions of the foundations made sand islands impracticable, and the tidal flow as well as the nature of the soil rendered false bottoms for the caissons too hazardous. As a result, an innovation in caisson flotation and control, involving the diving-bell principle, was introduced. An article in the April 5 issue will describe this difficult and novel foundation work.

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New York

March 29, 1934

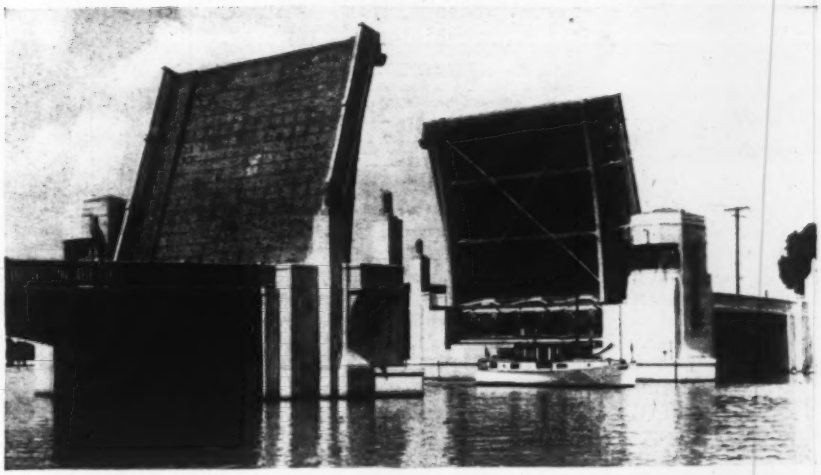


FIG. 1—FLOOR, CURBS, SIDEWALKS AND RAILINGS of bascule leaves are made up of welded steel plates and shapes. Colored concrete panels are used on the piers and colored tile trim on the control and operator's houses. Note how pier fenders are separated from the piers. Also the glass front in the machinery room beneath the bascule leaf.

Architectural Details Emphasized in Bascule-Span Bridge

Double-leaf center span of structure at Port Clinton, Ohio, made to resemble arched side spans—Steel painted to match concrete, and green trim and aluminum lights used—Floor, sidewalk and railing welded

By J. R. Burkey

Chief Engineer of Bridges, State Department of Highways, Columbus, Ohio

IN A NEW BRIDGE recently opened over the Portage River at Port Clinton, Ohio, particular attention was given to the architectural detail of design in order to produce a modern and pleasing appearance of the structure as a whole. The bridge consists of a central double-leaf bascule span of 80-ft. clearance, with a 60-ft. approach span at each end. The double-leaf arrangement of the bascule span was adopted so as to obtain an arch appearance that would resemble the outline of the outside girders of the approach spans. Measured parallel to the center line of the roadway, each pier is 27 ft. long, while each abutment has a length of 45 ft., providing concrete masses of considerable proportions. The total length of the bridge is 344 ft., while the roadway is 40 ft. wide between curbs, and a 5-ft. sidewalk is provided on either side. The structure was designed for an H-20 loading.

In addition to architectural details, a welded railing of unusual design and a battle-deck type steel floor are features of the project.

Architectural treatment

All steelwork was painted to match the concrete color of the substructure with an additional touch of color added by placing precast green panels of metallized concrete on the ends of the piers and on the roadway sides of the operator's house and the control house. These houses, located at either end of the bascule span and on opposite sides of the roadway, have green copper roofing and a horizontal band of green tile inserts near the top of the walls. All roadway lighting fixtures are made of cast aluminum.

The railing, massive and substantial, is of all-steel construction on the bascule and approach spans and is made to match almost exactly the concrete railing provided over the abutments and retaining-wall approaches. The make-up of the railing is somewhat unusual. The top of the top rail is a ¼-in. plate, and two steel cross-tie sections (Carnegie M-27) comprise the sides. A standard 6-in. channel forms the bottom of the top rail, and square holes, cut in the web of the channel, admit 4-in.-square steel posts used as spindles. The bottom rail utilizes a 6-in. standard channel as the top piece, while two of the steel cross-tie sections serve as sides. The railing was fabricated by arc-welding and the panel units joined to 12-in.-square posts made by bending and weld-

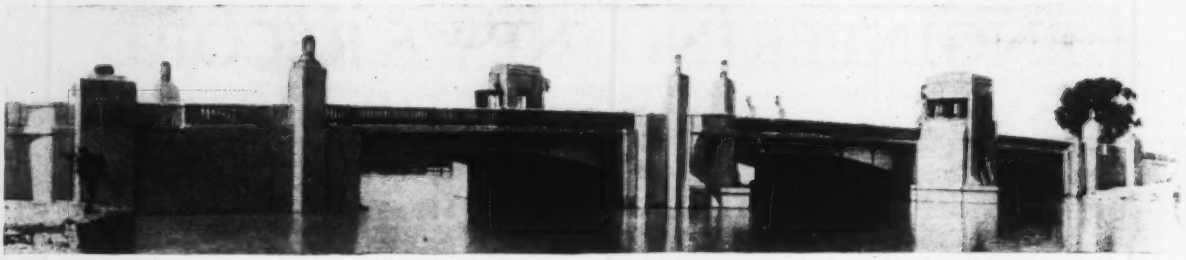


FIG. 2 — ARCHITECTURAL composition received special attention in the design of this three-span bridge, in which the center span is a double-leaf bascule proportioned to harmonize with the two end spans.

ing ⅞-in. plate material. The posts are provided with special cast-iron caps.

Bascule and approach spans

The bascule span is of the double-leaf fixed-trunnion type. Each leaf is made up of two plate girders with curved bottom chords, connected by floor beams and supported on steel trunnion towers placed inside the hollow piers. The break in the floor is in front of the trunnion, and the floor over the counterweight is fixed, thus avoiding the dangerously large openings characteristic of certain types of bascule design.

A steel floor of battledeck type is used on the roadway and sidewalks of the bascule span and over the trunnion piers. For the roadway, ⅝-in. copper-bearing steel traffic plates laid normal to the center line of the roadway are plug-welded to the supporting beams, and all plates are joined to each other and to the supports by continuous welding of the seams. In the design the floor plates were considered as part of the compression flange of the supporting frame, permitting a considerable saving in weight of steel.

On the sidewalks ⅜-in. traffic plates are used, while a ½-in. smooth plate forms the curb face. The entire assembly, including curb, is welded to form a watertight deck over the supporting framework, which consists of built-up floor beams, spaced 14 ft. on centers between the main girders; 12-in. I-section stringers, spaced 3 ft. 4 in. on centers; and 6-in. I-section cross-beams spaced 2 ft. 4 in. on centers between the stringers. All framing is flush on top.

On the approach spans the intermediate beams are 36-in. rolled girder sections, spaced 5 ft. on centers, and the outside girders are composed of built-up sections with curved bottom flanges to give the appearance of an arch. Stiffener angles are omitted on the outside of the girders to enhance the general appearance of the structure and to produce a panel effect between the sidewalk brackets. On these spans a reinforced-concrete roadway and sidewalk slab are used.

The abutments are of U type, not filled above the natural ground level but topped with a reinforced-concrete floor of beam-and-slab construction. The fenders on the piers are of reinforced concrete, 18 in. thick, extending in height from a point slightly below low water to an elevation somewhat above high water. Each side of the fender wall is about 12 ft. long and is supported by three 10-in. H-beam columns anchored in the pier footing. A 12-in. open space is provided between the fender and the pier to allow for movement of the fender when subjected to the impact of navigation or ice. Flexibility is obtained through the bending of the steel supporting columns.

Crushed limestone and limestone sand were used for aggregates in all concrete. Mixes were 1:6½ for footings and counterweights and 1:5½ for all other work.

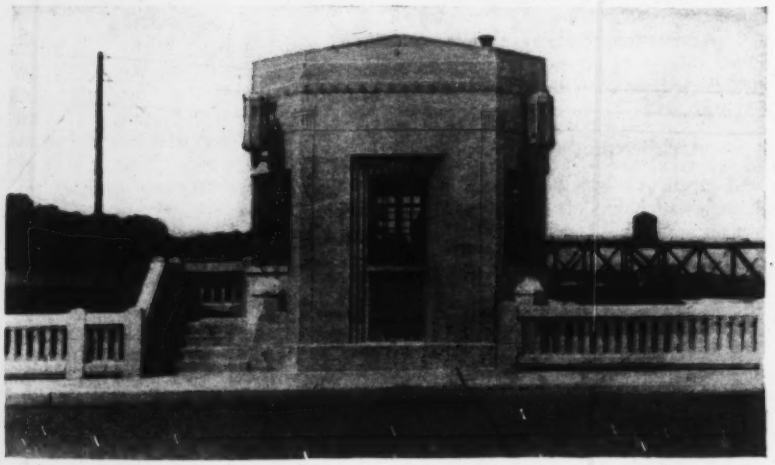
The control house is two stories high with the second-floor level about 4 ft. above the sidewalks. From the main control bench board located in the upper room all main operations are carried out. The remote-control switchboard is located in the lower room. The operator's house, similar to the control house, is equipped as living quarters for the bridge tender.

The operating machinery is placed in a room situated between the trunnion towers below the deck. Electric current for power and lighting is obtained from a 440-volt service line, distributed to two 30-hp. main motors, two 5-hp. sump pump motors, four 3-hp. gate motors and all lighting fixtures. Sumps are located in each pier.

The project was financed cooperatively by Ottawa County and the Ohio department of highways as part of the federal emergency relief program. The contract was awarded in December, 1932, to A. Bentley & Sons Co., Toledo, Ohio. The total contract price, including all extras for the bridge proper, was $575,825, while the contract price of the approaches was $20,742. The R. C. Mahon Co., Detroit, furnished and erected all of the structural steel and machinery.

The engineering and architectural designs were prepared in the bureau of bridges, Ohio department of highways, under the direction of the writer. W. H. Rabe is chief designing engineer and W. H. Hintman acted as coordinating engineer in the design of the structure and had direct charge of field work. Machinery and electrical features of the bridge were designed by H. W. Bowden and F. C. Nesbitt, while the architectural design of the control houses was handled by Josephine Howard, all parties being members of the bureau of bridges. O. W. Merrell is director of highways, H. P. Chapman is chief engineer, and Elmer Hilty is chief engineer of construction for the state of Ohio.

FIG. 3—ARCHITECTURAL DETAIL of the control house. Color is supplied by a trim of green tile near top and by aluminum lamp fixtures, as well as by a metallized concrete panel below the window. Railing is made up of welded-steel plates and shapes, proportioned and painted to match the concrete railing of the approaches. Floor and sidewalks are steel traffic plates plug-welded to supporting beams in a battledeck-type design.



LARGE RETAINING-WALL TESTS

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IV—Effect of Capillary Forces in Partly Saturated Fill

Analysis of capillary forces as they complicate pressure phenomena and affect the results of tests on drained backfill of fine material

By Karl Terzaghi
Professor, Technische Hochschule, Vienna, Austria

IN a preceding paper (*ENR*, Feb. 22, 1934, p. 259) the results of tests with coarse submerged sand were described. When this sand was drained the voids of the material became practically empty; water remained only in the form of thin films covering the surfaces of the individual grains, and the weight of these films did not exceed 2.5 per cent of the total weight of the sand. In a subsequent series of tests the backfill consisted of a modified till of glacial origin, whose effective size was less than one-thirtieth the effective size of the sand. When this till was drained, its voids remained practically filled with water, due to the small size of the grains. The difference between the average weight of the saturated and the drained till was less than 1 lb. per cubic foot. Most of the water was retained within the fill by capillary forces. These forces have a marked influence on the test results, and they complicate the pressure phenomena to a considerable degree. Hence, before presenting in the following paper the results of the earth-pressure tests with "modified till" an attempt will be made to analyze the various factors involved.

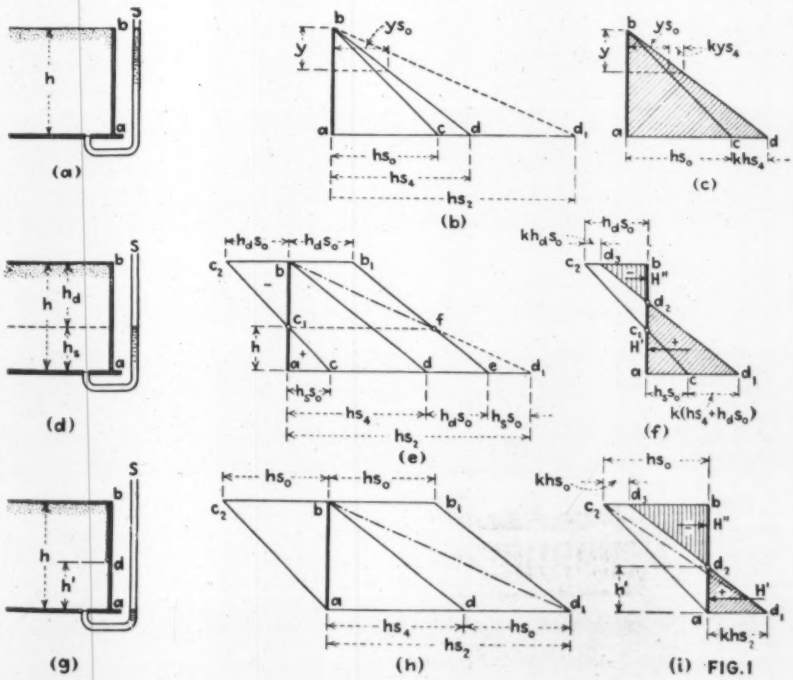
Drained backfill in capillary saturation

We will assume a retaining wall backfilled with fine but cohesionless sand to a depth h less than the height h_c through which water could rise in the material by capillary action. The symbols to be used in the following computation of the forces that act on the back of the wall are: h and b = depth and width of the fill; s_0 = unit weight of the water; s_1 = unit weight of the fill, excluding the weight of the water contained in the voids; s_2=unit weight of the fill with the voids completely filled with water (complete capillary saturation); s_3=average unit weight of the fill with the voids partly filled with water (partial capillary saturation); s_4=unit weight of the fill reduced by full hydrostatic uplift; $W'_0 = \frac{1}{2} \cdot s_0 bh^2$ = the water pressure that acts on the wall when the backfill is replaced by water; W'_1, W'_2, W'_3, W'_4 = the pressures exerted on the wall by liquids of unit weights of s_1, s_2, s_3, s_4 respectively; H=the horizontal component of the pressure that acts on the wall; V=the vertical component of the pressure that acts on the wall; tan δ=the coefficient of wall friction; k = the hydrostatic pressure ratio for the lateral earth pressure—that is, the ratio between the horizontal component of the pressure of the solid fraction of the backfill and the corresponding liquid pressure.

Drawings (a), (d) and (g) in Fig. 1 show sections through the wall with the backfill in three different stages of saturation: (a) completely submerged, the water level in the standpipe located at the elevation of the surface of the fill; (d) partly submerged and partly in a state of capillary saturation, the water level in the standpipe at a depth h_d below the surface of the fill; and (g) in a state of complete capillary saturation, with the level in the standpipe at the base of the fill. The depth below the surface of the fill to which the water was lowered in the standpipe will be called the "suction head," and that part of the fill that is contained within this depth is the "suction zone."

In the diagrams (b), (e) and (h) of Fig. 1 are plotted the vertical normal pressures which act at different depths y below the surface. According to the conclusions presented in a preceding paper, the presence of the backfill has practically no reducing influence on the forces that act in the liquid content of the voids of the fill. Therefore, in every case the pressures which act in the water are represented by the abscissas of a straight line (line bc in Fig. 1b, line cc_2 in Fig. 1c and line ac_3 in Fig. 1h). According to the laws of hydraulics, the standpipe level represents the boundary between nega-

FIG. 1—PRESSURES on wall with the backfill at three different stages of saturation.



tive and positive hydrostatic pressures. That part of the vertical pressure which is transmitted from grain to grain through the solid fraction of the fill is also represented, in every case, by a straight line *bd*. Since the grains of the backfill are almost completely surrounded with water, the effective unit weight of the sand is equal to s_s, and the base of the pressure triangles *abd* is equal to hs_s.

At a suction head h_d (Fig. 1d) the surface tension of the water acts on the surface of the fill like a surcharge with an intensity $h_d s_o$ per unit of area. Since this force is transmitted through the solid part of the backfill to the base of the container, the quantity $h_d s_o$ must be added to the abscissas of the pressure lines *bd* for the solid part. Thus we obtain, for the solid part, the pressure lines b_1e in Fig. 1e and b_1d_1 in Fig. 1h.

The same result can be obtained from the following consideration: At any point of depth *y* the total vertical pressure must be equal to the sum ys_s of the weight of the sand and the water above this point. This total weight is represented in diagrams (b), (e) and (h) of Fig. 1 by the straight line bd_1. To obtain the pressure line for the solid fraction of the fill, we simply reduce the length of the abscissa of *bd* by the length of the corresponding abscissa of the line of the water pressure *bc* in Fig. 1b, cc_2 in Fig. 1e, ac_2 in Fig. 1h. Thus we obtain the pressure lines *bd* in Fig. 1b, b_1e in Fig. 1e, and b_1d_1 in Fig. 1h respectively.

The determination of the pressure which acts on the vertical back of a retaining wall is based on the following consideration: At any depth the horizontal pressure exerted by the liquid content of the fill is equal to the vertical pressure that acts in the liquid at the same elevation. On the other hand, the horizontal pressure exerted by the solid part at any depth *y* is equal to the corresponding vertical pressure multiplied by the hydrostatic pressure ratio *k*. This reduction expresses the influence of the frictional resistances acting at the points of contact between the grains, which increase in simple proportion to the pressure transmitted within the solid. The resultant lateral pressure is equal to the algebraic sum of the (positive or negative) pressure exerted by the liquid and the pressure of the solid. By performing this simple operation we obtained the pressure lines *bd* in Fig. 1c and d_1d_2 in Fig. 1f and Fig. 1i. The shaded areas inclosed between these lines and the vertical axis *ab* represent the total pressure on the wall. The areas located above point d_2 (Fig. 1f and i) are negative pressures (capillary suction), and those below this point are positive.

The diagrams (c), (f) and (i) of Fig. 1 clearly demonstrate the effect of the capillary forces on the pressure phenomena: When the water level in the standpipe is lowered, the lateral pressure rapidly decreases and can even assume a negative value. If capillary forces do not exist, the horizontal component of the lateral pressure of the backfill (Fig. 1g) should be equal to $\frac{1}{2}kh^2s_s$. The capillary forces reduce this pressure to $\frac{1}{2}kh^2$ $(s_s + s_o) - \frac{1}{2}h^2s_o$. Another effect of the capillary forces consists in shifting the center of the pressure from the middle third toward the base of the wall. Finally, if the upper part of the wall in Fig. 1g should be removed, the fill would stand unsupported with a vertical slope.

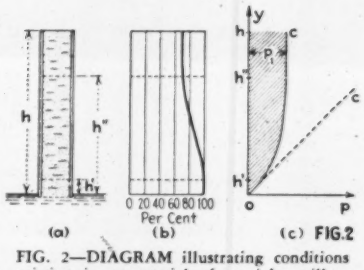


FIG. 2—DIAGRAM illustrating conditions existing in a material of partial capillary saturation.

This effect of the capillary forces can easily be demonstrated by means of the following experiment: Fill a cylindrical sieve with very fine, saturated sand; dump the content of the sieve on a table after the excess water has escaped through the perforated bottom of the vessel; the upper part of the body of sand will now stand at a vertical slope. On the other hand, if the vessel be dumped under water, the sides of the body of sand will be sloped over their full height regardless of how carefully the operation was performed.

If an attempt is made to measure the intensity of the lateral pressure by means of scales, the following difficulty is likely to arise: An insignificant impetus may suffice to cause the formation of an open fissure between the wall and the fill, extending from the surface of the fill to the depth $h - h'$ in Fig. 1g, and then the capillary suction will no longer act on the upper part of the wall, the scales recording only the positive pressure H' (Fig. 1f and 1i), while the negative presure H'' remains unknown.

Drained backfill in partial capillary saturation

In the preceding analysis we assumed that the voids of the backfill in both the submerged and the suction zone are completely filled with water. But this will rarely be the case in cohesionless backfills. To understand what conditions prevail in a material of partial capillary saturation, let us suppose a slender cylindrical vessel, Fig. 2a, completely filled with very fine sand and completely immersed in water. The height of the vessel is supposed to be considerably greater than the height h_c to which the water would rise within its content by capillary attraction. Hence, if we lift the vessel vertically, so that only the lowest part of the vessel remains immersed, part of the water will drain out. In the upper part of the column, above a height $h'' > h_c$, the amount of water replaced by air will be independent of the height above the free water level and will depend essentially on the size of the grains; in the lower part, below a height $h' < h_c$, the voids will remain completely filled; and between these parts there will be a zone of transition.

The height h_c of capillary rise is smaller than h'' but considerably greater than h', because when water rises by capillarity into a column of dry sand the upper part of the wetted section of the sand is always in a state of partial capillary saturation only. Fig 2b shows a diagram of the percentage of the voids which will be filled with water at different elevations above the free water

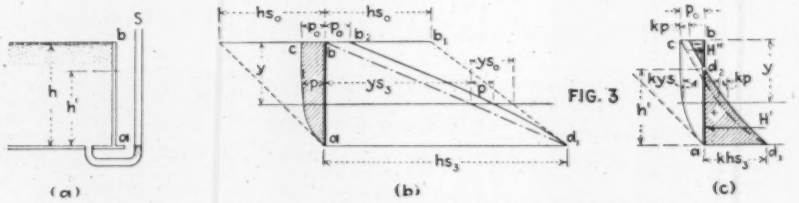


FIG. 3—COMPUTATION of lateral pressures exerted by backfill in partial capillary saturation.

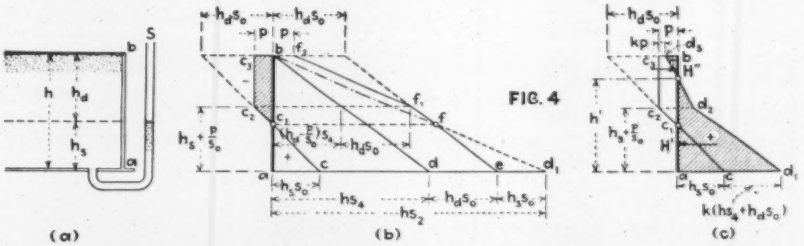


FIG. 4—INFLUENCE of partial capillary saturation limited to upper part of backfill.

level. In numerous measurements on fine silty sands from the flood plains of the lower Connecticut River as much as 90 per cent of the voids remained permanently filled with water at a height many feet above the upper level of capillary saturation. For such materials the value s_2 and s_3 are practically identical. In the upper part of the vessel the average curvature of the surface of the films of water will be everywhere the same and equal to the smallest curvature consistent with the grain size, because the water is confined to the narrowest parts of the voids. Therefore, above the zone of transition the negative hydrostatic pressure will assume a constant value p independent of the elevation and merely depending on the grain size and density of the granular material. In the diagram Fig. 2c the negative hydrostatic pressure is represented, for any elevation, by the abscissas of a curve OC with vertical asymptote.

From these facts computation of the lateral pressure exerted by backfill of partial capillary saturation may be attempted. Fig. 3 shows a cross-section through the back of the wall. Prior to drainage the conditions were identical with those shown in Fig. 1a to Fig. 1c. After drainage, the water level in the standpipe sinks to the level of the base of the fill, Fig. 3a. Since the depth of the fill is greater than the height h_c of the capillary rise, the vertical negative hydrostatic pressures which act within the water are determined by the abscissas of curve ac in Fig. 3b, while for the fill in a state of complete capillary saturation (Fig. 1g) we obtained for the negative hydrostatic pressures a straight line ac_2. The vertical pressures transmitted through the grains of the sand are determined in the same manner as in Fig. 1h. At every depth y (Fig. 3b) below the surface of the fill, the abscissas ys_2 of the straight line bd_1 represent the weight of both the sand and the water located above this elevation. In order to get the total vertical force which acts on the sand at depth y we must add to the pressure ys_2 a pressure p which is equal and opposite to the negative hydrostatic pressure p acting at the same depth in the water. Thus we obtain the pressure curve d_1b_2. The lateral pressure at depth y is equal to the algebraic sum of the negative hydrostatic pressure p and the product of the hydrostatic pressure ratio k multiplied by the vertical pressure $(ys_2 + p)$ acting on the grains of the sand, or lateral pressure $= k(ys_2 + p) - p$. Thus we obtain the pressure diagram Fig. 3c.

The shape of the curve ac in Fig. 3b can only be guessed at, and any computation based on an assumption involving a variable value of p would be complicated. In order to derive approximate formulas for estimating the effect of the capillary forces on the intensity of the lateral pressure, we replace the curve ac of Fig. 3b by the broken line cc_2c_3 as shown in Fig. 4b for a backfill under the influence of a suction head h_d which is smaller than the depth h of the backfill but greater than the height h_c of capillary rise. When dealing with this case we assume that the unit weight s_3 of the partly saturated material is practically equal to the unit weight s_2 of the saturated material.

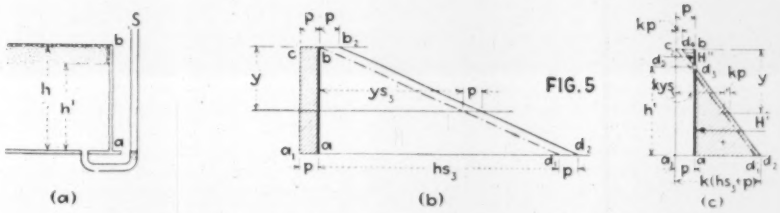


FIG. 5

FIG. 5—VERTICAL PRESSURE is combined weight of water and sand plus capillary pressure.

Application of the principles evolved in connection with the preceding example leads to the following results: The vertical pressures that are transmitted from grain to grain are represented by the abscissas of the broken line cf_3f_2 of Fig. 4b, and the horizontal pressures which act on the back of the wall by the abscissas of a broken line $d_1d_2d_3$, Fig. 4c. By comparing Fig. 4b and Fig. 4c with Fig. 1e and Fig. 1f we realize that the influence of the absence of complete capillary saturation is limited to the upper part of the backfill between the surface and a depth $h_d - p/s_0$ (h_d = suction head and p = average intensity of the capillary pressure within the upper part of the zone of suction). Within this upper part the vertical pressures transmitted from grain to grain may be computed as though the weight of the sand were equal to the full weight of the sand plus the full weight of the water contained in the voids, and furthermore as though the surface of the fill carried a surcharge p per unit of area.

For the case in which the suction head h_d is equal to the depth h of the backfill, Fig. 5a, we may further simplify the analysis by assuming the negative hydrostatic pressures to vary as the straight line a_1c of Fig. 5b, instead of as the broken line $c_1c_2c_3$ of Fig. 4b. In other words, we disregard the fact that the negative hydrostatic pressures decrease to zero in the lowest part of the suction zone. The vertical pressures which act in the solid part of the backfill are represented by the abscissas of b_2d_2, Fig. 5b, and the horizontal pressures exerted by the solid and the liquid part of the backfill jointly are given by the abscissas of the straight line d_2d_4, Fig. 5c. The procedure for determining the position of these pressure lines is identical with that described in connection with Figs. 3 and 4. According to Fig. 5b, the vertical pressure which acts at any depth y below the surface is equal to the sum of the combined weight ys_2 of water and sand and capillary pressure p. Above point d_2, Fig. 5c, the resultant horizontal pressures are negative, while below this point they are positive.

The data presented in Fig. 5c can be used for the interpretation of the results of earth-pressure tests. The analysis is based on the following assumptions:

The horizontal and vertical components of the lateral pressure are measured by scales, first for the fill in a completely submerged state and then for the fill in the state represented by Fig. 5a. With the wall in stationary position, both drainage and saturation cause the hydrostatic pressure-ratio to increase from k to $mk > k$, due to rearrangement of grains during the period of transition from one state to the other. According to the conclusions presented in Article I, such increase occurs even in dry backkfill during a period of rest.

During the test with drained fill, the upper part of the backfill (above point d_2, Fig. 5c) usually pulls loose from the wall. Hence the scales merely measure the positive part of the lateral pressure.

Based on these assumptions, we now wish to determine the average intensity p of the negative hydrostatic pressure (capillary suction) and the coefficient of wall-friction $\tan\delta$ for the drained state.

In the computations the symbols are used which were quoted at the beginning of the paper. In addition, the letter H_s is used for the measured horizontal pressure component in the submerged state and H_d in the drained state. The value of the hydrostatic pressure ratio is obtained from the results of the test on the submerged fill by using the equation $H_s = W_s + kW_s$, so that $k = (H_s - W_s)/W_s$.

For the drained state the measured pressure is, according to our assumptions and to Fig. 5c,

$$H_d = \tfrac{1}{2} h' mkhs_3 \frac{h}{h} b = \tfrac{1}{2} h'^2 mks_3 b \quad (1)$$

$$\text{and } h' = h\frac{mk(hs_2 + p) - p}{mkhs_3} = h\left[1 - \frac{p(1 - mk)}{mkhs_3}\right] \quad (2)$$

Since $\tfrac{1}{2} h^2 s_2 b = W_3$, we obtain

$$H_d = mk\, W_3\left[1 - \frac{p(1 - mk)}{mkhs_3}\right]^2 \quad (3)$$

$$\text{and } p = \left[1 - \sqrt{\frac{H_d}{mk\, W_3}}\right]\cdot\frac{mkhs_3}{s - mk} \quad (4)$$

The measured vertical component of the lateral pressure of both the submerged and the drained backfill is equal to the product of the coefficient of wall friction tan δ times that part of the lateral pressure which is transmitted to the wall through the grains. For the drained backfill there is no contact between the wall and the fill above point d_3 of Fig. 5c. Therefore the vertical component is equal to

$$V = \tan\delta \cdot \text{area}\,(a_1 d_2 d_3)\, b \text{ (width of the fill)} = \tan\delta\,(H' + ph')\, b$$
$$= \tan\delta\,(\tfrac{1}{b} H_d + ph')\, b$$

$$\text{or } \tan\delta = \frac{V}{H_d + bph'}$$

From eq. (1) and (3) we obtain

$$h' = \sqrt{\frac{2H_d}{mks_3 b}} = h \cdot \sqrt{\frac{H_d}{m\,k\,W_3}}$$

$$\text{Hence } \tan\delta = \frac{V}{H_d + bph\sqrt{\dfrac{H_d}{m\,k\,W_3}}} \qquad (5)$$

If we drop the assumption that the backfill pulls away from the wall, the measured pressure becomes $(H' - H'')b$, and we obtain from Fig. 5c

$$H_d = b\,(\tfrac{1}{2}\, mkh^2 s_3 + m\,k\,h\,p - h\,p)$$

$$\text{Whence } p = \frac{\tfrac{1}{2}\, m\,k\,h^2 s_3 - H_d}{h\,(1 - mk)}\, b = \frac{m\,kW_3 - H_d}{bh(1 - mk)} \qquad (6)$$

$$\text{and } V = b \tan\delta\,(\tfrac{1}{2}\, m\,k\,h^2 s_3 + hp) =$$
$$b \tan\delta\,(m\,k\,\frac{W_3}{6} + hp)$$

$$\text{or } \tan\delta = \frac{V}{m\,k\,W_3 + b\,h\,p} \qquad (7)$$

Conclusions

1. When draining a fine-grained, saturated backfill equipped with a standpipe, a very small discharge may lower the water in the standpipe through a great vertical distance. This vertical distance is the suction head, and that part of the fill located above standpipe level is the suction zone.

2. Within the suction zone the hydrostatic pressures in the water content of the fill are negative. These negative hydrostatic pressures are maintained by the surface tension of the water, which in turn acts on the solid part of the backfill like a surcharge.

3. The effect of the surface tension (capillary forces) on the backfill depends on whether the depth of the suction zone is smaller or greater than the height h_c of capillary rise in a dry column of backfill material.

4. If the suction head is considerably smaller than h_c (state of complete capillary saturation) the surface tension of the water acts exclusively at the top surface of the fill. In this case the vertical pressures which are carried at any depth by the grains of the backfill may be computed on the assumption that the unit weight of the solid part of the fill is reduced by the full hydrostatic uplift, and that the surface carries a surcharge equal to the suction head times the unit weight of the water.

5. If the suction head is considerably greater than h_c (state of partial capillary saturation), the places where the surface tension acts on the grains are scattered throughout the major part of the suction zone, and within the zone the intensity p of the capillary pressure is practically independent of the depth below the surface. Within this zone the vertical pressures carried at any depth by the grains may be computed on the assumption that the weight of the fill is equal to the full weight of both the sand and the water and that the surface of the fill carries a surcharge equal to p. Below the suction zone the vertical pressures carried by the grains have exactly the same intensity as if the suction zone were in a state of complete capillary saturation (see conclusion 4).

6. In every case an increase of the suction head causes a substantial decrease of the lateral pressure and a downward movement of the center of pressure.

7. The horizontal unit pressure which acts at any depth on a vertical surface is equal to the sum of the full (positive or negative) pressure which acts at this depth in the liquid part of the backfill and the product of the vertical pressure which is carried at the same depth by the grains of the backfill times the hydrostatic pressure ratio.

8. For a backfill in a state of partial capillary saturation the various elements of the lateral pressure and the intensity of the capillary pressures may be computed by Eq. (4), (5), (6) and (7).

Previous articles in this series appeared in our issues of Feb. 1, p. 136, Feb. 22, p. 259, and March 8, p. 316.

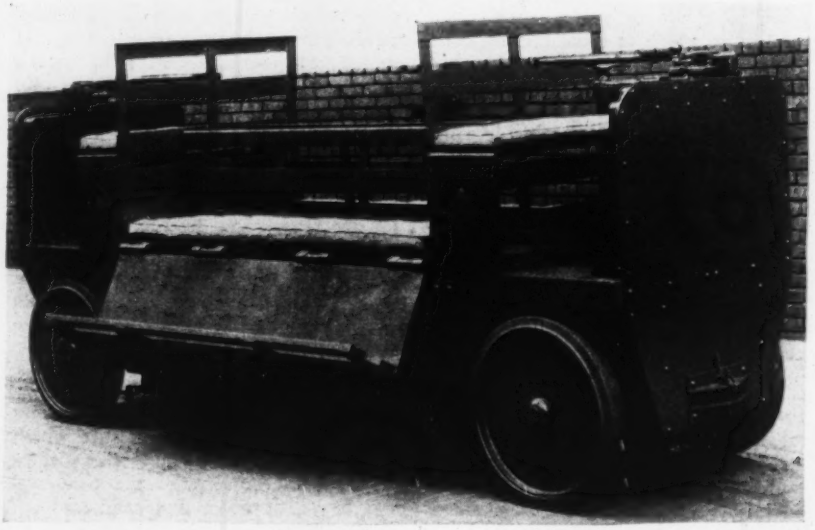
Special Inspection Car Built for Use in Hetch Hetchy Tunnel

TO FACILITATE inspection work in the 28.5-mile Coast Range Tunnel of the Hetch Hetchy water-supply system for San Francisco, the water department of the city has built an electric truck, shown in the accompanying illustration. Working from one end, a round trip through the entire tunnel amounts to about 60 miles. Consequently the inspection truck is equipped with storage batteries capable of 72 miles of continuous travel. Electric drive was chosen in preference to an internal combustion engine on account of the limited air supply within the tunnel. Special explosion-proof controllers eliminate danger from the explosion of gases.

The inspection truck is designed to carry twelve men and 500 lb. of equipment or to haul four tons of supplies on trailers. It is designed to operate from either end with speeds low enough to permit continuous inspection, if desired, and yet with high enough speeds to permit rapid movement to any particular point in the tunnel. On account of the circular section of the tunnel, there is no plane surface upon which to run the truck, and consequently steering is through a high gear ratio to give accurate control.

The inspection truck was built by the Elwell-Parker Electric Co., Cleveland, Ohio.

ELECTRIC INSPECTION TRUCK for Coast Range Tunnel of the San Francisco water-supply system. It is operated by a storage battery capable of 72 miles of travel without recharging.



Iowa Engineering Society Meets at Ames

Active annual meeting reviews progress of PWA, CWA and CCC, and discusses current technical investigations and studies

WITH a registration nearly equal to the 375 members in good standing, the convention of the Iowa Engineering Society, at Ames, March 7 and 8, indicated that engineers of the Middle West have again assumed an active interest in community effort and the benefits of society discussions. The society program was preceded by a well-attended conference of surveyors; interest in surveying has been stimulated by the local control surveys undertaken by the U. S. Coast and Geodetic Survey. The society's technical program of eighteen papers, including highway, structural, municipal, mechanical, electrical and railroad section meetings, was followed by a business session at which reports were rendered by a dozen standing committees on the status of the engineer and engineering.

A feature of the meeting, as is usual this year at state society meetings, was the reading of full reports by engineer representatives of PWA, CWA and CCC.

PWA, said P. F. Hopkins, state engineer, attributed most of its troubles to wage scales and slowness in Washington. Applications filed number 256, representing an estimated cost of $19,100,000; 32 were withdrawn, leaving a total of 224 estimated at $17,500,000. About one-half of these applications have been approved. Of these, 39 projects have already been completed, 23 have been started, 13 are ready and on 20 to 25 the contracts will be let this spring. The distribution is essentially: water, 7 per cent; sewers and treatment, 18 per cent; schools and public buildings, 25 per cent; electric light and power plants, 15 per cent; highways and bridges, 34 per cent; and miscellaneous, 1 per cent.

CWA, according to a paper by George J. Keller, state engineer, built 175 miles of shale and gravel roads, drained marshes, straightened and dredged rivers (wheel-barrow work), erected athletic bleachers and built 4,600 ft. of river wall in Des Moines as the major larger projects. One-half the work consisted of grading. It proposed to improve 90 airports, but work was done on only twelve.

CCC, said Prof. G. B. MacDonald, director, began to function without delay on a 25-year state conservation plan and is restoring 20 drained lakes and making 30 new ones, providing access to lakes at 250 points and doing much on soil erosion which can be carried forward by farmers.

Codes, salaries and fees, ethics, legislations and regulation, taxing systems land surveying, public health, sanitation, and state reorganization were all reported on by respective committees.

On public health, the committee reported an examination of the water for fluorides of 510 supplies of the total of 543 in the state. Of 110 having from a trace to 8 p.p.m., 48 have 2 p.p.m. or more. Two small towns are abandoning their supplies as a result, and in five towns with supplies showing 3 p.p.m. or more the school children have mottled teeth. Statistics of other states generally show mottled teeth not prevalent where the supply has 2 p.p.m. or less.

On the technical program some of the more important papers related to anti-skid characteristics of road surfaces, rigid-frame analyses, shear distribution in concrete slabs, stresses in a continuous-span bridge and amount and distribution of heavy Iowa rainfalls.

Officers for the coming year are: president, Clarence Moriarty; vice-presidents, O. C. Ayres and A. A. Baustian. John S. Dodds, Ames, is secretary-treasurer. The next meeting will be held in Des Moines.

Skidding tests

Prof. R. A. Moyer, Iowa State College, described the experiments being made to determine coefficients of tire friction on various kinds of road surfaces in Iowa, Illinois and Indiana, utilizing a two-wheeled trailer behind a truck equipped to sprinkle the road in simulation of rain. The results of some of these tests were reported to the Highway Research Board (*ENR*, Dec. 14, 1933, p. 722) but further tests have been made recently, particularly with reference to skidding on curves and the use of chains with various spacing of cross-chains. With respect to the latter phase of the work, a 3-in. spacing seems to be the most effective for passenger vehicles.

Iowa rainfall analysis

Records of rainfalls in Iowa of more than 4 in. per day, comprising useful information for designing bridges, culverts, drainage ditches and levees, are available in U. S. Weather Bureau reports for the 30-year period ending in 1920. Similar records for 1921 to 1933 have been compiled by W. J. Schlick, drainage engineer, Iowa Engineering Experiment Station, and were discussed in his paper on "The Magnitude and Distribution of Heavy Rainfalls in Iowa." The county was used as a basis for studying the geographical distribution, although it was realized that seldom is a storm uniform over as large an area as an average Iowa county. A study of the data indicates the following:

Frequency of heavy rainfalls bears no definite relationship to normal rainfall. Also records for two particular counties show fifteen heavy rainfalls during the 44-year period, while there were none in one adjacent county and twelve in another, with nothing of a physical nature as an explanation. The greatest storm in the 44-year period, in terms of area covered, was that of Aug. 26-28, 1903 which produced 4.55 to 11.22 in. in fifteen counties. Another storm from Sept. 17-19, 1926, produced rainfalls of 4 in. or more in thirteen counties in the northwest quarter of the state. Most 4-in. storms extend over not more than three or four counties. The average number of 4-in. + rains over the 44-year period was 4.3 per county, or a total of 426.

Utilizing the methods proposed by the late Allen Hazen for streamflow studies, but not generally used for rainfall data, to determine the probable frequencies of rainfalls of different intensities, the maximum rainfalls for each of the 44 years were tabulated and plotted on logarithmic paper as ratios to their mean. The graphs indicated that some localities in Iowa should report a rainfall of 4 in. in 97 per cent of the years; for the same localities the tabulation shows such rainfalls in 95.5 per cent of the years. Similarly, 6-in. rainfalls should be expected in 68 per cent of the years, while a count of the record shows 61 per cent. Once per 100 years the maximum should be 13.45 in. The maximum recorded rain is 13 in., with three records of 12 to 13 in., six of 10 in. or more, and ten of 9 in. or more.

Transportation coordination

Progress in coordination of railway and highway transportation was outlined by Prof. R. B. Kittredge in a review of the various agencies working on the problem. One report cited was that of the Bureau of Railway Economics (November, 1933) which was devoted in part to a discussion of the allocation of street and highway costs to the different vehicle classifications. One computation resulted in the conclusion that passenger cars, school buses and trucks of less than 1½-ton capacity, representing 91 per cent of the total number of vehicles, ought to pay only 45 per cent of the total cost of roads, while the remaining 55 per cent of the cost should be borne by the other 9 per cent of the vehicles which imposes the heavy loads on the highways. The way in which highway costs are to be divided bears importantly on the questions of weight and dimensional limitations. Recommendations of the American As-

sociation of State Highway Officials, adopted Nov. 17, 1932, are 8,000 lb. per wheel and 16,000 lb. per axle.

In conclusion, and in reference to the future of highways and railways, Professor Kittredge stated that if regulation and taxation could coordinate so that each might serve with maximum utility within its proper field, many problems of both railway and highway finance would be greatly simplified, the threat of government ownership would disappear, and the interests of the public would be best served.

Concrete-slab design

The distribution of shearing stresses in concrete slabs under concentrated loads was reported upon by M. G. Spangler, associate structural engineer, Iowa Experiment Station, Ames. Most experimental work on this problem deals only with concentrated loads placed near the transverse center line of the slab and not near one support which is the position of load to produce maximum shear in the slab. The author began some experiments on this phase of the problem in 1925, and studies have continued from time to time under his direction since then. The paper was in the nature of a progress report in which the experimental methods were reported in detail, and the results obtained from tests on twenty individual slabs were given. (See also *ENR*, Jan. 25, 1934, p. 118, for résumé of report made by Professor Clyde T. Morris, Ohio State University, on the same problem.)

Two types of apparatus have been utilized in the Iowa experiments, each designed to measure the reaction at one end of imaginary longitudinal elements of the slab equal in width to one-tenth of the total slab width. The first, referred to as the "lever method," consisted of a series of levers with movable counterweights to balance the reaction on each element. The second, called the "friction method," utilized a series of stainless-steel ribbons, which were free to slide between brass surfaces in such a manner that the vertical reaction on each ribbon was proportional to the horizontal pull required to start the ribbon sliding.

In the lever method set-up the slabs were built with one end resting freely upon a concrete pier and the other end upon a series of ten cast-iron bearing blocks, each 4½ in. wide in the direction of the span and of length equal to one-tenth the width of the slab transverse to the span. Each block transmitted its load through a ball-and-socket joint to a steel saddle that rested on a pair of hardened knife edges, one on either side and one at one end of a cold-rolled steel bar about 42 in. long and ½ in. in cross-section. The fulcrum of the lever was 2 in. ahead of the receiving knife edge and consisted of another pair of knife edges resting upon an inverted steel saddle, which in turn rested upon a concrete pier. A 17½-lb. movable counterweight rode the free end of the lever to balance the applied load. Also a 1-lb. rider was provided for finer adjustment of the balance.

In the friction method of measurement a series of bearing blocks supported the slab exactly as in the lever method. The load from these blocks was transmitted through a ball-and-socket joint to a pair of cast-iron blocks, one above the other. Each of the two surfaces between these blocks was lined with a layer of brass shims backed by a thin layer of canvas. A stainless-steel ribbon, ½ in. wide and 0.008 in. thick, passed between these brass surfaces. The pull required to start the ribbon sliding was proportional to the vertical load on the bearing block, depending upon the coefficient of friction between the brass surfaces and the steel ribbon. This coefficient was determined in advance of the installation by loading the ribbon assembly in a testing machine. The 20 slabs tested ranged in thickness from 2½ to 6½ in., in span from 3.5 to 10.0 ft., and in width from 5.0 to 7.5 ft. The first thirteen of these slabs were tested by the lever method, and the rest by the frictoin method.

Most of the experiments were directed toward determining the effective width for the reaction and the discovery, if possible, of the laws that control its variation. There appear to be two factors that influence the effective width for maximum shear stresses—namely, thickness of the slab and distance of the load from the edge of the slab. Apparently, neither the span length nor the total width of the slab exert an appreciable influence on the effective width.

The effective width for any given thickness of slab is a minimum for loads placed near the edge of the slab and increases approximately in straight-line ratio as the load is moved toward the longitudinal center line, reaching a maximum value at some distance from the edge, which is a function of the thickness and independent of the total width of slab. An empirical relationship that appears to fit the data satisfactorily is as follows:

$c = 0.75 + 0.1\ t + x$ in which c = effective width, in ft.; t = slab thickness, in in.; and x = distance from edge of slab to load, in ft. The maximum value of $x = 1 + 0.2t$. This empirical expression is offered tentatively until something more rational is evolved.

Great Loss to Water Department From Faulty Meter Reading

RESULTING directly from a long period of faulty reading of meters, the Bureau of Water of Cicero, Ill., had to charge off its books $164,900 in 1933, representing the value of water that had been used by consumers in excess of the amount for which they had been billed. Cicero in 1930 had a population of 66,602.

According to the annual report of the Bureau for 1933, it was the general practice in Cicero, previous to April 19, 1932, to give meter readers books that contained all previous readings. With the previous readings before them the readers merely estimated the meter registrations instead of actually reading them. When a check was made during a campaign undertaken by the Bureau to remedy defects in its distribution system, meters were found that had been out of order for several years but for which estimated readings had been made every half year and bills based on these estimates had been sent out. Other meters were found that had accumulated excesses for several years because the consumer had been billed at the minimum rate.

By ordinance all one-flat buildings in Cicero are required to pay a minimum bill of $3 for usage up to 3,000 cu.ft. The minimum bill for a two-flat building is $5; a three-flat building, $7; and a four-flat building, $9. Because of the practice of estimating meter readings, most of the bills had been for the minimum.

To correct this, after April, 1932, meter readers were given sheets that contained only the addresses of the buildings. Having no knowledge of the previous readings, they then had to make the actual readings.

Billing under the new system brought abnormal results for a time. Bills for one-flat buildings ran from $5 to $100. Bills for two-flat buildings ran from $10 to $150. The huge bills were the result of reading the accumulated excesses of water that had been used over a period of years, but that had never been paid for.

The report states: "It would have been unjust to have made the user the innocent victim of this practice, so most of these excessive bills were adjusted and the amounts written off the books."

A check-up by the meter readers revealed that of 13,000 meters in Cicero nearly 4,000 were out of order. Most of these users had been paying minimum bills, although a majority of them had been using a great deal more water. To facilitate the replacing and repair of faulty meters, a workshop was established. Up until December, 1933, more than 2,000 meters had been replaced.

Sewage-Plant Operation Data from Decatur, Ill.

DURING 1933 the sewage-treatment plant at Decatur, Ill., reduced by 90 per cent the polluting qualities of the city's sewage before discharging it into the Sangamon River, as is indicated by the reduction of the biochemical oxygen demand from 206 p.p.m. in the raw sewage to 19 p.p.m. in the final plant effluent. Detailed operating data for 1933 are tabulated below.

The trickling-filter plant at Decatur receives, through a combined system, a sewage that contains large quantities of difficult trade wastes. About 40 per cent of the dry-weather flow is contributed by a cornstarch plant, the waste products of which are high in organic content and of high temperature. As a consequence, although the sanitary district's population in 1933 was but 58,000, the volume of sewage when the industrial plants are operating has a population equivalent of about 100,000 to 120,000.

A long history of investigation of sewage-disposal schemes preceded the construction of the plant. In 1922 grit chambers, Imhoff tanks, trickling filters and secondary sedimentation basins were built. The plant was placed in operation in 1924. Aeration tanks were added in 1926 and are used for preaerating the Imhoff tank effluent before applying it to the trickling filters. This relieves the load on the filters and increases the capacity of the plant to provide for a population equivalent of 150,000. A pumping station to discharge the plant effluent during high water was built in 1930. Primary sedimentation tanks, used for stormwater only, and separate sludge-digestion tanks were added in 1932. Including the interceptor system, the cost of the plant to date is $1,750,000. Pearse, Greeley and Hansen, consulting engineers, Chicago, Ill., designed the plant and its additions.

The design and operating data in the accompanying tables were furnished by W. D. Hatfield, superintendent. The flow figures cited were determined by venturi meters. Analytical results are based on 24-hour composites of hourly samples.

SEWAGE-PLANT PERFORMANCE DATA, SANITARY DIST. OF DECATUR, ILL.

GENERAL DATA

Population, 1933	58,000
Population served, 1933 (holiday equiv.)	40,000
Rated capacity of plant, m.g.d.	10
Sewage flow	
Average m.g.d.	9.2
Maximum day, m.g.d.	23.7

SEWAGE-TREATMENT UNITS

Coarse Screens	
Number of units	3
Width of opening, in.	1¼
Submerged area of screen, vertical projection, sq.ft.	43
Angle of screen with horizontal, deg.	35
Method of cleaning	manual
Grit Chambers	
Number of units	1
Plan dimensions, each unit, ft.	2 — 8x7½; 1 — 10x7½
Operating depth, including grit space, ft.	4
Depth allotted to grit space, ft.	1-2
Method of cleaning	manual
Frequency of cleaning	twice a month
Primary Sedimentation Tanks	
Number of units	3
Plan dimensions, each unit, ft.	100x47
Operating depth, including sludge space, ft.	15
Provisions for sludge removal	longitudinal scrapers
Capacity sewage flow, each unit, m.g.d.	22
Detention period at maximum flow, each unit, min.	30
Imhoff Tanks	
Number of units	6
Plan dimensions, each unit, ft.	96x28
Settling compartment, each unit.	
Depth to slot, ft.	11
Area of cross-section, sq.ft.	141
Sludge compartment, each unit, cu.ft.	30,300
Sewage flow, all units, m.g.d.	9.2
Detention period, all units, (actual flow), hours	1.25
Trickling Filters	
Number of units	2
Area each unit, acres	1½
Sewage flow, all units, m.g.d.	9.2
Type of filter material	crushed limestone
Depth of filter material, ft.	6
Type of distributing system	spray nozzle
Type of underdrain system	ridge-and-furrow
Pre-Aeration Tanks	
Type	diffused air, spiral flow
Number of units	6
Length of travel, each unit, ft.	200
Width, each unit, ft.	16
Depth of sewage, each unit, ft.	16
Type of air diffusers	porous plate
Total area of air diffusers, sq.ft.	1,600
Sewage flow, all units, m.g.d.	9.2
Return sludge, all units, m.g.d.	0.17
Mixed liquor Volume settled in 1 hr., c.c. per liter	6.5
Suspended solids, p.p.m.	160
Air used, cu.ft. per gal. sewage	0.34
Detention period (based on sewage plus return sludge), hr.	2.6
Secondary Sedimentation Tanks	
Number of units	1
Plan dimensions, each unit, diam. in ft.	75
Operating depth, including sludge space, ft.	12
Provisions for sludge removal	rotating scrapers
Sewage flow, all units, m.g.d.	9.2
Detention period at actual flow, all units, min.	32

SLUDGE DISPOSAL

Sludge Digestion Tanks	
Number of units	2
Plan dimensions, each unit, diam. in ft.	50
Depth, each unit, ft.	25
Capacity, each unit, cu.ft.	51,000
Temperature maintained, deg. F.	80-90
Sludge-Drying Beds	
Number of units	16
Length, each unit, ft.	100
Width, each unit, ft.	25
Depth of sludge applied, in.	12-15

ANALYTICAL RESULTS

	Settleable Solids (1 hr.) c.c. Per Liter	Suspended Solids, p.p.m.	Five-day B.O.D., p.p.m.
Raw sewage	2.8	205	206
Imhoff-tank effluent	0.4	72	153
Trickling-filter effluent	1.3	64	24
Secondary-tank effluent	0.7	45	19

SCREENINGS, GRIT AND SLUDGE

	Volume, Cu.Ft. Per M.G.	Dry Solids Per Cent	Volatile Solids Per Cent	pH	Disposal
Coarse screenings	0.44	....	..	...	Burial.
Grit	7.05	....	..	...	On roads; fill.
Primary-tank sludge	....	7-10	17	7.2	To digestion tanks.
Imhoff-tank sludge	151	12	35	7.0-7.2	To drying beds in summer; to digestion tanks in winter.
Separate-tank digested sludge	....	13	35	7.2	To drying beds.
Dried sludge	70	....	..	...	To farmers, parks.

Supervision of Ohio Water and Sewage-Plant Operation

SUPERVISION of the operation of water purification and sewage-treatment works in Ohio must be by a registered professional engineer, under the terms of the state registration act which went into effect on Jan. 1. This is the construction placed by the state board of registration for professional engineers and surveyors on Sect. 1083-2 of that act which provides in part, "The practice of professional engineering within the meaning and intent of this act includes any professional service, such as consultation, evaluation, planning, design, or responsible supervision of construction or operation, in connection with any public or privately owned utilities, structures, buildings, machines, equipment, processes, works or projects, wherein the public welfare or the safeguarding of life, public health or property is concerned or involved, when such professional service requires the application of engineering prinicples and data."

According to *Ohio Health News*, Feb. 15, 1934, the state department of health understands that the law will be complied with if part-time technical supervisors of small plants are registered, providing the supervisor assumes full responsibility for the operation of the works. In order to comply satisfactorily with this latter requirement, it is obvious that the supervisor shall perform more than cursory and infrequent visits and inspections of his plant.

Roller-Gate Dam Erection at Rock Island, Ill.

World's largest installation of roller gates signalizes first navigation dam completed for 9-ft. canalization of upper Mississippi River

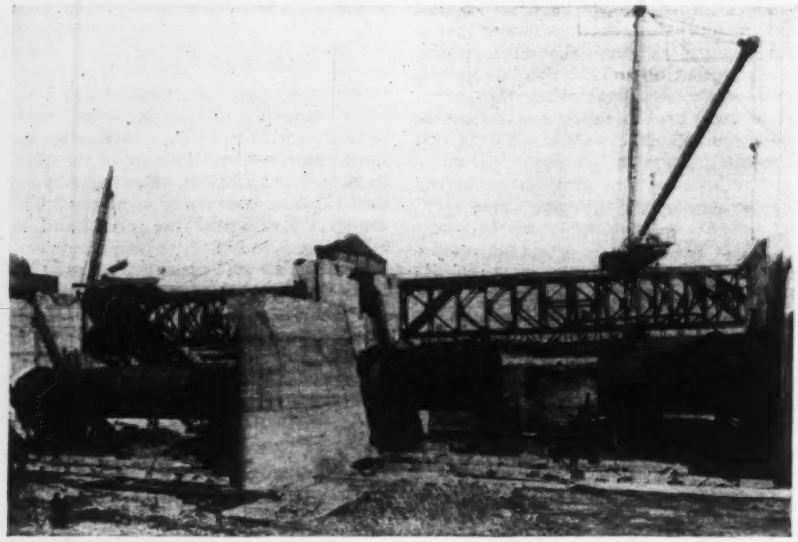


FIG. 1—ROLLER GATES for Rock Island navigation dam being erected from service bridge by 60-ton derrick. Roller ends travel on racks in pier niches.

A ROLLER-GATE DAM extending 1,200 ft. diagonally across the Mississippi is an outstanding part of the canalization works at Rock Island, Ill., the dual ship locks of which were described in *Engineering News-Record*, March 15, 1934, p. 342. This dam, with the inclosing locks, seawall and levees, creates a 6,000-acre pool over what was formerly the Rock Island Rapids. The installation, officially opened on March 2, is the first to be completed of the two-dozen new navigation dams built to provide a 9-ft. channel on the Mississippi River from St. Louis, Mo., to St. Paul, Minn. In length and number of gates it is the largest roller-gate installation ever made, although individual gates both longer and larger have been constructed in America and more particularly in Europe, where this type originated.

In an article to be published soon the design of the roller-gate movable dam will be reviewed. The present article deals solely with the structure and construction of the Rock Island dam, officially designated as Dam 15 in the Mississippi series (*ENR*, March 8, 1934, p. 322). Like others of the series its structural elements are a concrete sill or fixed crest carrying the gate piers and appurtenant stoplog and poiree-needle bulkheads, the movable gates and a service bridge. These parts will be considered in order.

Dam structure

Unlike most of the dams of the Mississippi series, the Rock Island dam has a full roller-gate spillway; generally a combination of roller gates and tainter gates has been adopted. Another feature is the installation of two gates with a crest elevation 4½ ft. lower than that of the other gates to provide a continuous overflow for sluicing out ice or drift from the upper pool when the gates are necessarily closed or but slightly open. All gates are 109¼ ft. long over all and have a 100-ft. clear opening; the two end gates forming the sluiceway have a damming height of 21¾ ft., and the nine intermediate gates a damming height of 26 ft.

The unusual arrangement of the gates in steps (Fig. 2) was adopted to insure the greatest effective spillway length. By this plan of dam it was possible to reduce the pier width to 11 ft., and for every 111 ft. of distance between pier centers to obtain 100 ft. of clear spillway. Thus 90 per cent of the dam length can be removed from the water if the need arises. The fixed crest of the dam is the top of the sill against which the apron of the roller-gate seat as shown by Figs. 4 and 6.

Piers and Sills—Each pier, as shown by Fig. 3, is recessed on both sides for the trackways of the roller gates. These trackways are more clearly indicated by Fig. 6. To take the stresses developed by gate operation and the head of water, unusual reinforcement of the thin concrete pier shafts was necessary. Similarly the sill slab between piers was closely laced with steel; the crest sill is to take the pressure of the roller gates, and the bulkhead and poiree dam sills will withstand the pool heads when the crest sill is cofferdammed off for repairs. A general indication of the extent and arrangement of the pier and the sill-slab reinforcing is given by Fig. 3. In round figures, 32 tons of reinforcing steel was required for each pier.

In addition to the roller gates, the piers had to take the load of the service bridge and the pressure of the upstream emergency bulkheads when the gates were out of service for repairs. These are steel stoplogs with roller ends (Fig. 4), which slide down between piers in vertical slots and seat on a sill; when in place, they cofferdam the roller-gate sills for the upper pool. Each stoplog is a steel truss 106 ft. long, 3 ft. 7 in. high and 11½ ft. deep with wood seals to prevent leakage. Eight of these trusses laid flat form a bulkhead. To provide the downstream wall of the cofferdam, a poiree needle dam is carried on downstream sills, which are indicated in Fig. 4 and more clearly in Fig. 8; with the frames raised and the needles placed, the lower pool is shut off from the roller-gate sill. These unwatering facilities are developments of very recent American practice.

Roller Gates—The general arrangement of a roller gate and its operating appurtenances at Rock Island is illustrated by Fig. 6, and by the several views, Figs. 6 to 9. Design elements of roller gates will be discussed in a future article, and at the moment only structure and mode of operation will be outlined.

As shown by the illustrations, the roller gate is a riveted steel cylinder with a permanently attached lip or apron. The apron extends the full spillway distance (100 ft.) between piers, but the ends of the drum extend beyond the ends of the apron into niches in the piers and so transmit the water load to the piers. The niches are inclined, and by rolling the drum up or down in them the gate is open to discharge water or closed to dam the pool. At Rock Island the over-all gate length is 109¼ ft.; the two end-gate drums are 16 ft. 2 in. in inside diameter, and the nine intermediate-gate drums are 19½ ft. in inside diameter; the damming heights are 21¾ ft. for the end gates and 26 ft. for the intermediate gates; all drums have a clearance of 6½ ft. when rolled up above high water.

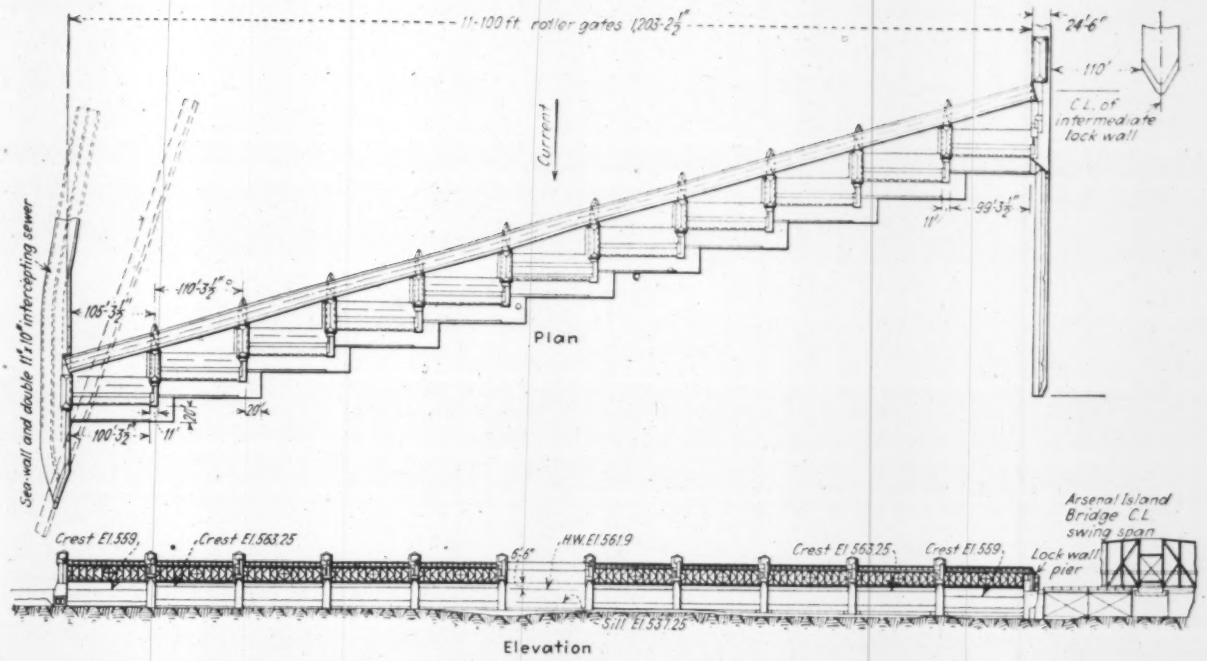


FIG. 2—ELEVEN roller gates arranged in steps enable 90 per cent of channel width to be opened at Rock Island navigation dam.

The gate is raised and lowered by rolling, exactly as any cylinder is rolled freely on an inclined plane. The rolling contact is made in the pier niches by drum racks meshing with track racks on the downstream ledges of the niches. A hoist and chain pulling on the gate at one end operates the gates. When closed, the apron of the gate bears against the crest sill. To seal the ends, a steel-plate shield is attached to each end of the drum. To the side of each shield next to the pier is bolted a timber that bears against a metal plate on the pier.

An interesting feature of the gates is the heating arrangement to keep the ends clear of ice. Each side seal is equipped with three 3-kw. heating units, and each end of the drum has three 4-kw. units.

Each gate is raised and lowered through a travel of 27 ft. 4½ in. for the large gates and 30 ft. 10 in. for the small gates by a triple-reduction, herringbone-gear hoist having a working load of 426,000 lb. It is designed to raise the gate at a speed of 6 in. per minute; the time required to open a gate fully is 55 min.

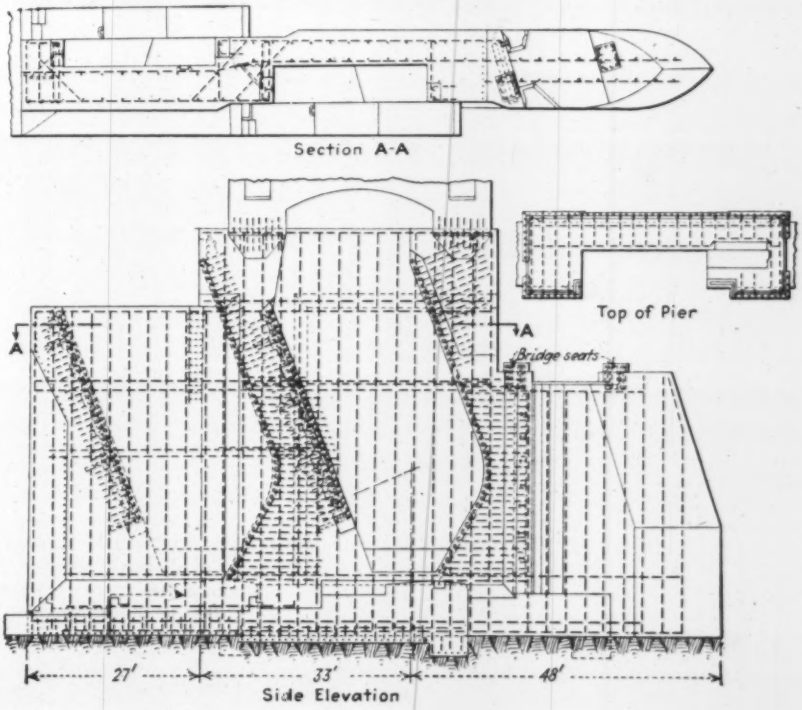
Service Bridge—The service bridge, as shown by Fig. 2, is an access way to the roller-gate hoists and a working platform for a locomotive crane on the top-chord deck and a bridge crane on the bottom-chord deck. The bridge crane handles the stoplogs for the upstream bulkhead, and the locomotive crane handles the poiree dam units and is used for general service.

Dam construction

Interest in the construction operations centers principally in the erection of the roller gates. For clear description this operation is best considered in respect to: (1) shop assembly of the gate parts into units convenient for shipment and field erection; and (2) field-erection procedure and plant. The construction of the masonry parts departed little from conventional river practices.

Pier Construction—All masonry and gate work was done in cofferdam. Starting at the Davenport side, the coffer was carried across the river in installments or sections about 500 ft. long, 200 ft. wide and 20 ft. high. The structure of the coffer was cellular, of steel

FIG. 3—HEAVY REINFORCEMENT required in piers and sills of Rock Island dam to resist gate, bridge and bulkhead loads.



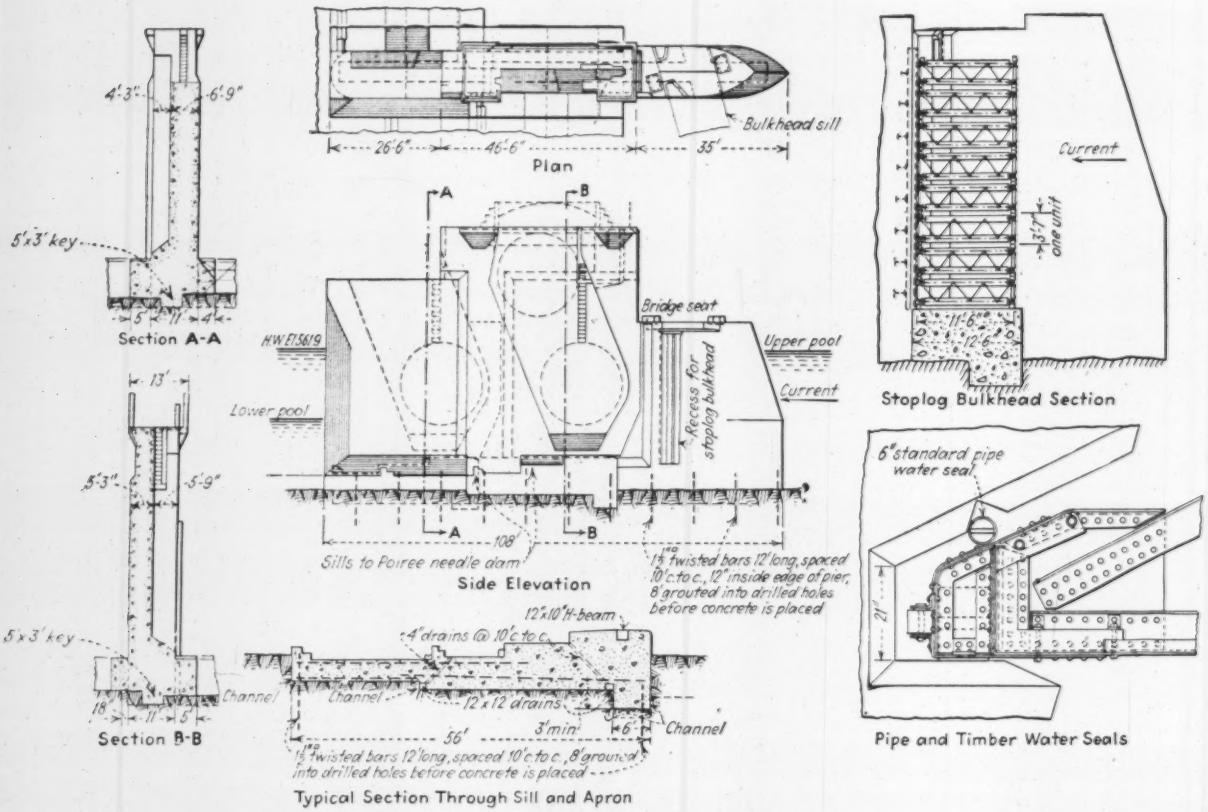


FIG. 4—PIER AND SILL details for roller-gate dam at Rock Island, Ill.

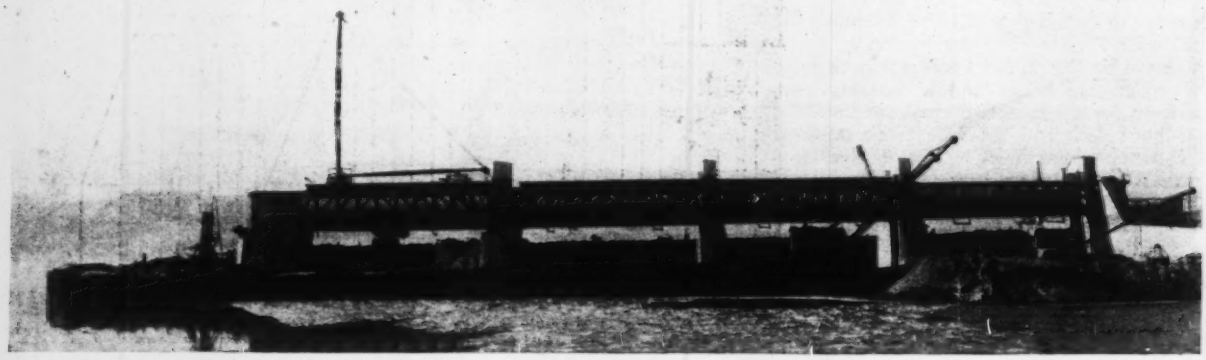
sheetpiles, as shown by Fig. 5, the cells being filled with sand. A section of coffer embraced four gates, and these were completed in full before the inclosing structure was removed.

The first operations in the cofferdam were the removal of the gravel overburden and the preparation of the rock by cleaning and cutting keyways for anchoring the sills and piers. The sills were a simple operation in formwork, but required some careful work in placing reinforcement, anchor bolts and fixed metal, as shown by Fig. 4. Greater complexity in these respects, as indicated by Fig. 3, was encountered in concreting the piers, which were heavily reinforced. The pier forms had a steel frame and wood panels; they were concreted in four lifts, floating-mixer equipment being used for the concreting operations in the first sections and track-traveling-mixer equipment in the last two sections.

Shop Assembly for Gate Erection—The gates and their appurtenances were a major job of steel erection; not only were they large structures, they were operating elements of a machine calling for precision in dimensions, line and level. In essence, steel cylinders 16 and 19 ft. in diameter and 109 ft. long had to be erected so that they could be rolled against all resisting forces by circumferential torsion applied at one end and not distort or lose expected sealing contacts or demand excessive operating power. This obligation indicated as complete a shop assembly as shipping rules would allow and field equipment could manage in order to reduce field assembly as much as practicable.

Each of the nine larger gates was assembled and shipped in 26 pieces. Each end of the 19½-ft. drum, with the racks attached, was shipped in halves split axially, making four end pieces. The intermediate length of the drum was shipped in segments 30½ ft. long and 10 ft. 2 in. on the arc. The apron was shipped in four lengths of about 27 ft. 5 in. The smaller end gates were assembled similarly and in parts of the same dimensions, but in only fifteen in-

FIG. 5—COFFERDAM carried across river in sections, each inclosing area for four spans of dam.



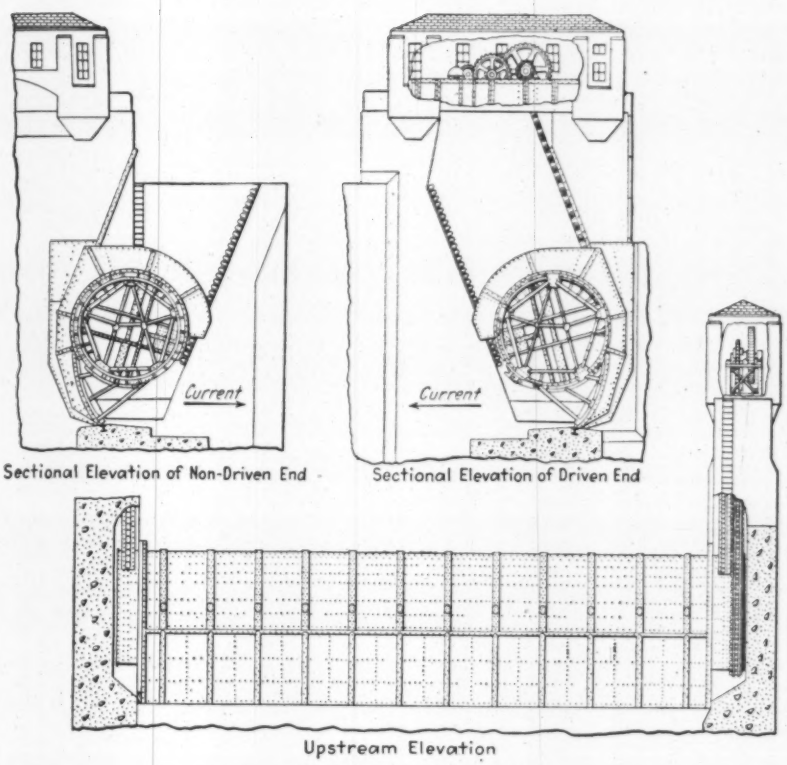


FIG 6—ROLLER-GATE ASSEMBLY, indicating gate structure and operating machinery

stead of eighteen parts for the intermediate length of drum. The hoist for each gate was shipped completely assembled. The chains 79 ft. long for the longer gates and 85 ft. long for the smaller gates were shipped in three pieces. Other minor parts were shipped in such sections as were convenient.

Field Erection—Gate erection began at the Davenport end of the dam in the cofferdam shown by Fig. 5, building out the service bridge, span following span and assembling the gates one after another. Side tracks and a yard crane on shore handled the gate and bridge parts. The method of erecting any gate was the same, and only the erection of the first gate on the Davenport side is described.

The first operation was to place 50 ft. of the service bridge on falsework. A 60-ton derrick (Fig. 1) was set up on the bridge to handle the gate parts into the hole for erection; the yard derrick placed the parts on a small car on the bridge. The falsework for the driven end of the gate was then erected and accurately lined.

The drum was erected in five rings, two end rings, two intermediate rings and a middle ring. First the intermediate ring next to the driven end was erected, beginning with the bottom segment and working up both sides to the top segment, bolting all connections. The two parts of the driven-end ring were then erected and bolted, and this ring was bolted to the intermediate ring. Next the driven-end rack and guide-rail was set in the pier niche, and the gate hoist and chain were then set on top of the pier.

A 60-ft. extension of the service bridge was made, and from it the crane erected the falsework for the non-driven end of the gate. On this, as described for the driven end, the intermediate ring and then the non-driven end ring were bolted up and then together. The end-ring seams were then riveted, and the niche racks and guide-rail at the non-driven end were set.

With the two end sections (two rings each) of the gate erected as described, they were rolled longitudinally back into the pier niches into exact operating position. The middle ring of the drum was then erected and bolted to the intermediate rings. Next the full drum was lined up, and seams where the apron was to seat on the drum were riveted. The apron was then placed and bolted, and the whole gate was again lined up. All seams and connections inside and outside, except for the apron braces, were then riveted.

After the gate was riveted and both drum and apron were lined up accurately, the niche racks and guide-rail and the gate hoist were lined and leveled and grouted in place. The grout was allowed to set about ten days, when the hoist chain was connected and adjusted. The gate was then rolled up and the falsework dismantled, after which the gate was lowered to the closed position and checked for the line of the seal timber. The seal timber was then bolted in place, the end shields straightened and lined, the end-seal timbers placed and planed to a close fit, the heaters installed and the interior walkway built. To test the gate, it was opened and closed fourteen times. In all there were 250 carloads of steel in the gates, bridge and bulkheads.

The dam was built under the immediate direction of the Rock Island District, Upper Mississippi Valley Division, U. S. Army. George R. Spalding, colonel, Corps of Engineers, was divi-

FIG. 7—INTERIOR BRACING of roller-gate drum made heavy to resist pressure head and torsion caused by applying rolling force to one end only.

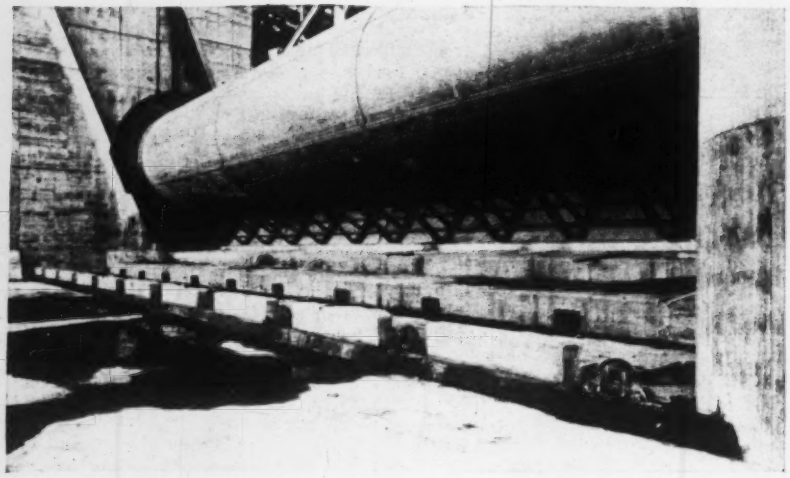


FIG. 8—ROLLER GATE closed with apron in contact with fixed sills. Downstream sills show hinges in place for poiree dam.

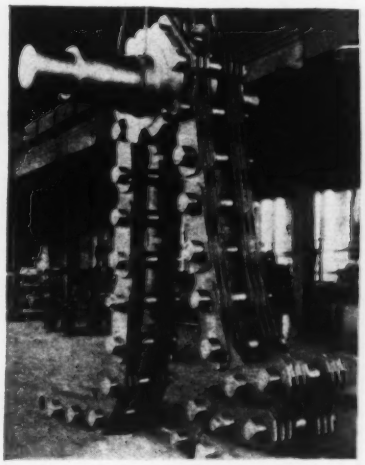


FIG. 9—CHAIN and hoist shaft for operating a roller gate at Rock Island dam.

sion engineer until Oct. 31, 1933. E. L. Daley, lieutenant-colonel, Corps of Engineers, has been division engineer since that date.

Glen E. Edgerton, lieutenant-colonel, Corps of Engineers, was district engineer until Sept. 4, 1933; R. A. Wheeler, major, Corps of Engineers, has been district engineer at Rock Island since that date.

S. A. Healy, Detroit, Mich., was general contractor for the dam, and the S. Morgan Smith Co., York, Pa., was contractor for the fabrication and erection of the roller gates.

Notes From the Road:

I—Winter Work in Wisconsin

Milwaukee, March 2, 1934.

HIGHWAY WORK makes up the bulk of Wisconsin's winter construction program, with a few scattered bridges and grade-crossing eliminations in evidence as one travels through the state. Road contracts have been let at a fast rate, but continued cold weather seriously hampered progress in the field. When frost gets 36 in. deep in Wisconsin clay, excavation or grading work becomes difficult. To the credit of officials and contractors alike, strenuous efforts have been made to keep road jobs under way. Projects were shut down reluctantly, and only after weather conditions made work impossible. Some jobs were discontinued only for a few days during the coldest weather.

Contractors on bridges and grade-elimination structures have solved the cold-weather problem with steam boilers and paper or canvas protection, and have succeeded in making mid-summer progress. Although the weather has been extremely cold, little snow has fallen, which is of some slight advantage to the shivering superintendents who dread the mess and hazards snow brings to every construction job. Perhaps it is because the finishers like to linger within warm inclosures, but at any rate the appearance of finished structures built in cold weather is remarkable.

TWO WISCONSIN BRIDGES built in winter. Left: rigid-frame grade-separation structure in Washington County. Steam heat kept this job going to scheduled completion, while the accompanying grading work has fallen far behind because of 3 ft. of frost in the ground. Right: three-span arch over Brown Deer River widened from 24 to 40 ft. The canvas and paper housing incloses freshly placed sidewalk and rail posts.

CWA work disorganized

Orders to curtail Civil Works projects caught officials unprepared. Hundreds of projects are being abandoned in critical stages. If the counties and townships can't finish up some of the road jobs started by CWA, traveling is going to be rough in spots this summer. School projects are reported to be in particularly serious condition, with repairs started, heating plants, walls and floors ripped out and no provision made for completion. Milwaukee got in some good work on its extensive park system with CWA labor. Throughout the state, wailing is loud and long on the part of merchants who claim CWA material and supply bills have never been paid. Government auditors are said to be going over all bills.

Baby bonds in Milwaukee

Two years ago Mayor Hoan was extolling Milwaukee's financial condition. Today the city is operating on baby bonds—IOU's of $10 face value—that

are accepted in certain stores at par, according to window cards, but, according to street gossip, are often discounted heavily elsewhere. However, Milwaukee has one distinction shared by few other cities of its class—a large PWA job has been under way for some time. This is an extension to the Jones Island sewage-treatment plant. G. R. Fehr, Milwaukee contractor, is placing all concrete for the plant by pumps, which are a new Milwaukee product encountered recently on several construction jobs. All the slabs for the aeration and sludge tanks are in place, and work is starting on the walls.

A call at the offices of the Milwaukee A.G.C. chapter found the place deserted except for an insurance agent whose sole connection with organized contracting is to answer occasional phone calls. He said he hadn't seen a contractor for so many weeks he could no longer recognize one. Two years ago the Milwaukee chapter was strong enough to swing the national A.G.C. convention.

Colonel Trippe, U. S. District Engineer, has an interesting job under way on the Fox River near Kaukauna, where a new lock is being built to replace an old one. Cold weather can't hold up this job, because it has to be ready for the opening of navigation. Two large government dredges hooked tandem furnish steam to keep the sand, gravel and concrete warm. Ears and toes don't fare so well, for the winds in this territory are blasts out of Lake Superior's refrigerator.

Traveling with District Engineer Stransky, of the state highway department, through several counties along the lake in an effort to find a job or two which hadn't frozen up, a couple of active bridge projects were encountered, but every grading job was shut down on that particular day.

H. W. R.

CWA WORKERS ignore a blinding snowstorm as they remove and clean paving brick from a Saginaw, Mich., street. As costs meant little, CWA projects throughout Michigan and Wisconsin were often kept going on days when contract work was shut down.

II—Slum Clearance in Chicago

Chicago, Ill.,
March 13, 1934.

WHILE DEMOLITION of slums in Chicago is proceeding at a snail's pace, except for an old jail and some few other municipal buildings, the legal methods by which privately owned structures may be made available to CWA workers have been worked out, thanks to the efforts of the Metropolitan Housing Council and the cooperation of the city of Chicago and CWA officials.

Much legal red tape surrounds the office of building commissioner in Chicago. Through his power to safeguard the public, he is permitted to order old buildings torn down. But to protect himself from damage suits it has been his custom to ask the City Council to declare specific dangerous buildings "public nuisances." Thus responsibility is shifted to the aldermen. For the council to order wholesale clearance of bad buildings, however, has not seemed feasible.

The above holds true even though the owner is willing to have his building razed, the commissioners still being advised by the city attorney that such condemnation is extralegal. It should be explained that city condemnation is desired by the CWA if it is to wreck the buildings, for by so doing the structure (not the ground) becomes city property, and consequently CWA is relieved of supervisory responsibility and disposal of debris and salvaged materials.

With only a brief existence ahead of it, CWA in Chicago hesitates to deal directly with the individual, even though such a type of slum-clearance project has been authorized by Washington.

Perhaps the greatest advance in Chicago has been made in exploring the methods of obtaining buildings for demolition. Four ways have been developed; first, through a recheck of the recent CWA Census, locating useless unoccupied buildings; second, through lists furnished by the building commissioner; third, through lists furnished by local improvement associations; and fourth, through requests from owners direct to CWA.

Details of the first method have been worked out so that the lowest-grade buildings can be selected. Owners' names are obtained from the Chicago Title and Trust Co., and their street addresses from county tax records. Ten people engaged in title searches on 1,000 buildings have found half of the owners. A map of buildings immediately available is kept up to date daily. The building department lists unfinished buildings and dilapidated buildings. When CWA is able to take them down, the city is expected to ask that it be done. The improvement association list furnishes the names of many buildings, but the owners' consents are few so far.

Letters are mailed to all owners on the lists, to check on the accuracy of their address before an engineer inspector looks over the building. This is done to prevent waste of time inspecting buildings when the owners are not available to sign statements asking CWA to do the work and giving access to the properties.

The forthcoming change in federal relief work is apparently going to transfer this demolition project to the State Relief Association, but will not otherwise change it significantly.

W. W. DEB.

Ford Building Added to Century of Progress

The largest new structure to be seen at the 1934 edition of Chicago's Century of Progress will be an exhibit building of the Ford Motor Co. The building will be something over 1,100 ft. long, with its dominant portion consisting of a circular structure rising in setback terraces to a height of 110 ft. At one side of the central structure there will be a smaller building housing some of the historic exhibits from the Edison Institute, while the main building on the opposite side of the central structure will be long and narrow, housing exhibits of the industries which contribute today to the automobile industry. The central building will house exhibits depicting the development of passenger vehicles from the earliest days. In addition to the area used by the building, a considerable amount of land between it and the lake will be landscaped and will include a bandstand.

Winter Bridge Building With Relief Labor

Concrete-arch structure about 1,000 ft. long built in Saskatoon, Canada, during period when temperature range was from zero to 40 deg. below—Aid to unemployed was substantial—Continuous concrete temperature readings kept

By C. J. Mackenzie
Dean of Engineering, University of Saskatchewan, Saskatoon, Sask.

WHEN IN 1931 it was proposed to undertake, under the auspices of federal, provincial and municipal authorities, a program of public works for relief purposes, the city of Saskatoon selected a bridge project over the South Saskatchewan River. A reinforced-concrete structure of five deck arches, with girder approaches, was designed for the site selected. It was to be known as the Broadway Bridge. The project contains several elements of technical interest both in its design and construction, and in addition is of importance because of its relief labor aspects.

The conditions set down by the authorities handling relief added greatly to the natural difficulties of the job. In the first place only a month was available between the time the project was authorized and the letting of the contract on Dec. 12, 1931. The year allowed for completion was further restricted owing to climatic and fluvial conditions which made it necessary to build the cofferdams and construct six piers, involving 9,000 cu.yd. of concrete, within a period of eleven of the most severe winter weeks, with the average daily temperature below zero most of the time and minimum temperatures of 40 deg. below zero prevailing for several days. Furthermore, the flood conditions of the river in June made it impossible to construct falsework in the river until early in July, and since subfreezing temperatures are common after the middle of October, the construction period for such work also was limited. Moreover, all labor had to be obtained on requisition from the relief office, and the use of machinery was restricted.

Abstract of a paper presented at the recent meeting of the Engineering Institute of Canada, ENR, Feb. 15, 1934, p. 244

Design elements

At the bridge site the elevation of the existing street intersection on the south bank was approximately 63 ft. higher than on the north bank, some 1,300 ft. away, giving an indicated grade of nearly 5 per cent. The river at high water is more than 800 ft. wide. It was decided to limit the grade of the proposed bridge to 4 per cent. The concrete-arch type for the main bridge was selected as being best suited esthetically and also because it would provide the greatest amount of local employment. The difficult problem of proportioning a bridge to connect two points of different elevations was solved by placing all arch springing lines at the same elevation and making the arches of varying span, but with an approximately constant rise-span ratio. It was decided that no pretentious ornamentation, portals or pylons would be suitable on a relief project. It was further decided to emphasize the straight line of the deck, making it continuous and well defined by using a simple poured railing, a heavy sidewalk fascia beam and a simple curtain wall to fill in the space between the top of the arch crowns and the floor system. This gave a line about 11 ft. deep. The arch rings and piers are plain, and the floor system is carried on the two arch rings by simple columns.

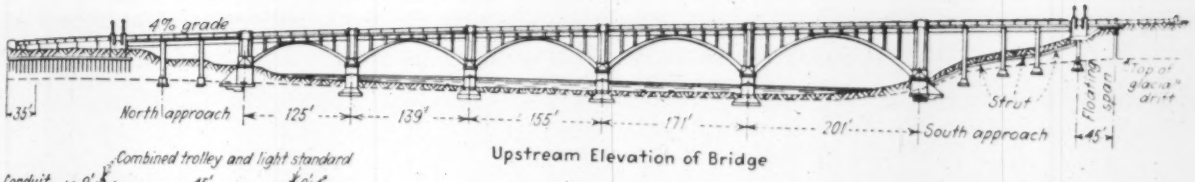
On the south the bank rises steeply to 100 ft. above the river and has a tendency to slip, being a glacial drift of blue clay overlaid with layers of sand, clay and quicksand. As built, the south approach consists of four girder spans from 40 to 48 ft. long, supported on four-column bents which rest on pedestals in the glacial drift. Each bent is braced laterally, and in a longitudinal direction a continuous line of struts is used, about 8 ft. below ground surface. The design was made on the basis that if the four columns at the refuge bay (Fig. 2) acted as a solid retaining wall of a length equal to that of the entire width of the bridge, the pressure of the pedestals against the glacial drift on the bottom would prevent the base from moving and the struts would carry the thrust at the top of the columns northward to the abutment shore pier. The southernmost span was designed as a floating span resting on a cap supported by piles; it was completely separated from the main bridge.

FIG. 1—BROADWAY BRIDGE, Saskatoon, Saskatchewan, built in eleven months by a contractor using relief labor and hand methods. Work carried on through severe winter. View taken downstream.

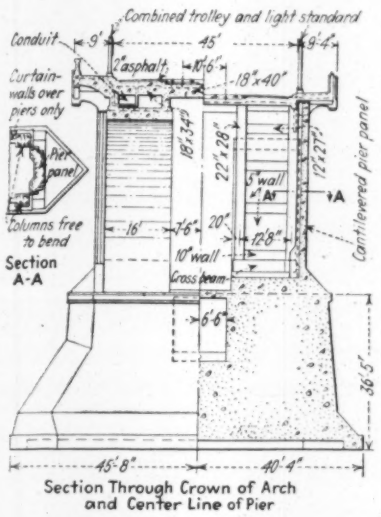
The arches being of varying spans, the column and floor-beam spacing had to be varied from 16 to 19 ft. both for esthetic and mathematical reasons. Each floor beam was carried on four columns, two on each arch ring at 12 ft. 8-in. centers with the two inner columns at 18 ft. 4-in. centers. This arrangement gave nearly equal column reactions on the arch ring and, in designing, the weight was considered as equally distributed.

Expansion joints for the deck were located over the piers only on the arch spans and at split columns on the approaches, of which there was one set in each approach. On the arch spans the pilasters over the piers were built as a vertical cantilever completely separated from the columns and deck, which move freely under changes in temperature.

For the design of the columns at the expansion joints, the deck, columns and arch rings were considered as rigid frames. Excessive moments at the bottom of the shorter columns, which could not be relieved by bending in the columns themselves, were eliminated by



Upstream Elevation of Bridge



Section Through Crown of Arch and Center Line of Pier

FIG. 2—ELEVATIONS AND SECTIONS of Saskatoon bridge. Built on a 4 per cent grade, arches have different spans but constant rise-span ratio.

using hinges similar in design to those used in Europe for arch rings.

In designing the arch rings the extreme temperature variation of the region (from 110 to minus 60 deg. F.) was taken into consideration, resulting in a wide, thin section. No allowance was made for deck participation.

Foundations for the bridge are carried on a glacial drift of boulder clay. The excavations extended about 10 ft. into this drift.

The construction period was divided naturally into three parts: first, winter—from Dec. 12, 1931, to the middle of March, 1932, during which time the river piers were constructed; second, the spring—from March to July, during which time floods caused work to be concentrated on the shore approaches; and third—the summer, from July to the middle of October, when the arch rings and floor system of the river spans were built.

Foundation construction

The river piers were inclosed in double-wall circular cofferdams made up of 6x12-in. tongue-and-groove sheetpiling with a clay puddle between. Excavation, under relief regulations, had to be done by hand, although air chisels were necessary to break up the drift. The excavated material was raised in buckets by hoists. Difficulty was encountered with ice which at one time rose to within an inch of the top of the cofferdam. A specially built combination piledriver and hoist, weighing about 12 tons, was for the most part moved directly on the ice, being carried on timbers which spread the weight over 280 sq. ft. An 18-in. thickness of ice was adequate to carry the load. In building the cofferdams a channel about 7 in. wide was cut with ice saws around the outline of the piers and the sheetpiling was set in place.

All concrete was mixed and placed under cold-weather conditions. Aggregates came from a pit 10 miles from the city, and great difficulty was encountered in keeping the roads open. Screening apparatus would not operate on the frozen material, and so pit-run gravel was accepted during the winter months. Crushed rock and a very fine sand had to be mixed with the gravel at the site to obtain a satisfactory grading. The pit-run material was analyzed from hour to hour, and the consistency of the concrete checked regularly by slump tests. The specified strength of 2,250 lb. per sq.in. was obtained by using 4.75 bags of cement to the yard with a maximum slump of 2 in. The aggregate was delivered by trucks directly on top of the aggregate shed, which was built into a side hill. Perforated 1½-in. steam pipes were laid at 6-ft. centers across the floor of the shed, and the aggregate was piled on top and heated to a temperature varying from 70 to 100 deg. F., depending on outside conditions. Mixing water also was heated.

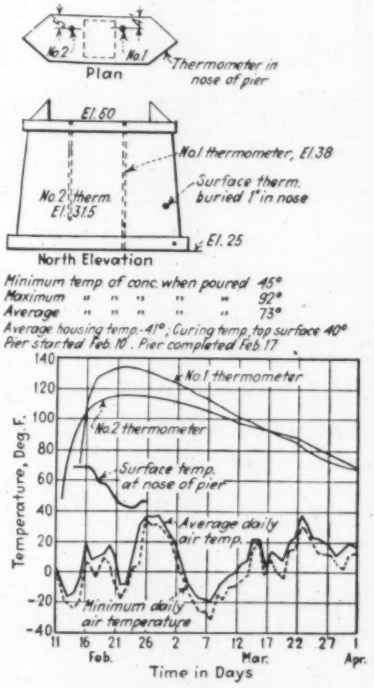


FIG. 3—CONCRETE TEMPERATURES in a typical pier from time of pouring, early in February, until April 1. Concrete was protected by tarpaulins while pouring, and thereafter by timber forms alone.

Relief restrictions required that the concrete be wheeled by laborers from the mixers to the piers. For this purpose a trestle runway was built at the level of the springing line of the arches. The common procedure was to pour a 2-ft.-thick mat in the open directly against the clay, there being no side forms. The portion from that elevation to about river-ice level was also poured in the open without protection, but forms were built up as work progressed. The portion from ice level to springing line, about 25 ft., was usually housed in and heated by steam and stoves.

As typical of the work, concrete was poured for two days and three nights continuously with a temperature of about 25 deg. below zero. On this pier the concrete was wheeled about 1,000 ft. It left the mixer at an average temperature of 90 deg. and lost only 2 deg. in transit. As the concrete was dumped into the footings, the top exposed surface froze quickly, but the frost did not penetrate far since each layer was soon covered over with a heated mass and thus thawed out; there was no alternate freezing and thawing.

When forming was started, tarpaulins were used to cover the surface of one end while pouring was concentrated at the other. In the interior of the pier the temperature of the concrete rose rapidly and within a few hours stood at 100 deg. The forms alone gave such protection that the thermometer against the forms never read below 50 deg. In the center of all piers tubes were installed (Fig. 3), and temperatures read daily.

As soon as high water receded in the spring, work on the river spans was undertaken. Most of the falsework for supporting the arch rings was made up of spruce poles, 7 in. in diameter at the top for main members and 3½ in. for bracing members. As this material was obtained from northern Saskatchewan, it not only provided local labor but was economical, since after demolition it was sawed into firewood. The falsework material was delivered at the water's edge on the south bank, sorted and cut to length.

Protecting thin members

The last part of the work, the superstructure, presented some unforeseen difficulties, since the first two weeks of October, 1932, were the coldest on record, with an average minimum temperature of 23 deg. and an average mean

temperature of 34.25 deg. Arrangements were made to heat the aggregates and mixing water, but it was not possible to protect the finished concrete. As the various members were poured, however, resistance thermometers with temporary leads were buried and a record was kept of the temperature maintained at the various points, to determine when and if forms might be removed. Concreting was under way on the floor slabs of one of the arches when the temperature started to drop (to a minimum of 18 deg.) The sidewalk, as it was finished, was covered with hot sand, sawdust and tar paper, but the road slab was too large to be protected in this manner. Fortunately there was available a steam boiler that had been used to heat the mixing water, and the only thing possible was to run hot water over the slab. This was done for three days and four nights until the weather moderated, and by this expedient the temperature in the center of the roadway was kept up to 56 deg. for the first day, 48 deg. for the second and well above freezing for the duration of the cold snap. No harm was done to the roadway, but the sidewalk was affected superficially at the curb edges. The hand rail was poured under these temperature conditions, and the top of the coping covered with tar paper, boards and manure. The forms, being quite heavy, also afforded protection.

Work on the street railway trackway on the center line of the bridge was complicated by the fact that curing as well as frost protection was necessary. The concrete aggregates and mixing water were both heated, so that concrete left the mixer at about 90 deg. In addition, calcium chloride was added to accelerate the setting. As soon as possible the trackway was covered with tar paper, carefully lapped, and this was covered with sand and manure. Air temperatures were from 10 to 12 deg. The temperature at the surface of the pavement went down from 90 deg. on the first day to 60 deg. by the fifth day. Since the temperatures inside the slabs were undoubtedly much higher, it is felt that satisfactory curing was obtained as there was little loss of moisture through the tar paper. The tar paper and manure were kept on for a month, and after a year's use the roadway is in excellent condition.

When pouring the floating approach span, temperatures of 10 deg. below zero were experienced. Special high-early-strength cement was used, and all aggregates and water were heated so that the concrete went in at 90 to 100 deg. As soon as the surfaces hardened they were covered immediately with tar paper and manure. Twenty-four hours after the slab was poured the street-railway track was laid and the trackway pavement poured. In 48 hours the asphalt pavement was placed on the roadway portions and a 10-ton roller carried without any damage. Temperatures on the surface were maintained well above 70 deg. for several days, and in the center of the 24x48-in. stringers the temperature was over 100 deg.

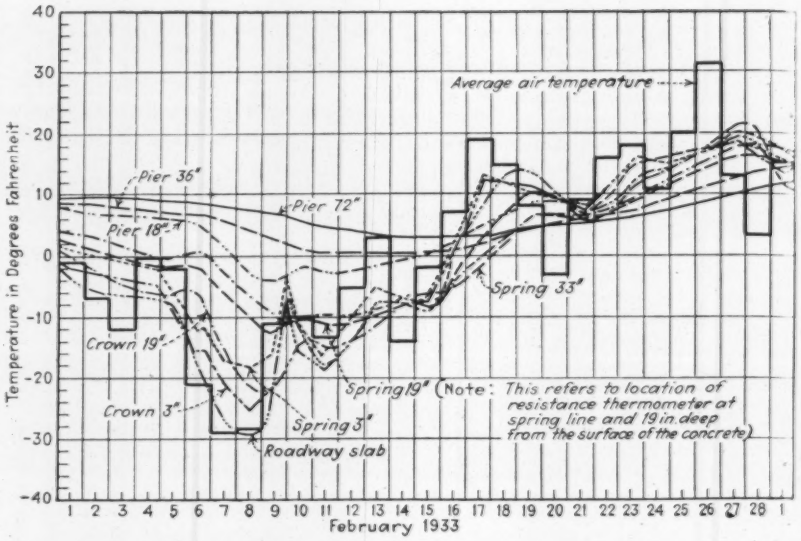


FIG. 4—COMPARISON of air temperatures with concrete temperatures at various points in finished structure. Moderating effect of river is noted on those locations near the water surface.

The bridge was opened for traffic on Nov. 11, 1932, less than eleven months after the contract had been awarded.

Labor handling and cost items

Since at least 50 per cent of the expenditure was for local labor, it was decided that the city engineering department should purchase all materials except lumber, and that the general contract would be essentially for labor, lumber, tools and small equipment.

All workers, with the exception of one lead man in ten, were to be rotated, no worker to be allowed to work over ten hours a day or to work over a set number of days a month—that is, a man with no children could not earn more than $25 per month, while the maximum for a man with a large family was $37.50. The contractor could select only three men from his own staff—a general superintendent, general foreman and accountant—and all other employees were to be requisitioned from the city relief office. The contractor had the right to discharge incompetent employees with the consent of the superintendent of labor. During the year 1593 different men were employed.

That the natural hazards of the job and the exacting relief conditions introduced a great element of uncertainty was proved by the fact that the bid of the lowest and successful bidder was less than 50 per cent of that of the highest and 33 per cent lower than the next responsible bidder. Quotations were asked in which the use of machinery was allowed also, and it was notable that the bids of the successful bidder under both conditions differed only slightly.

The cost of the bridge proper, exclusive of the street alterations at the approaches, was $640,000, of which $324,000 was paid in wages to residents of Saskatoon. This works out at a cost of $7.30 per sq.ft. for the entire bridge.

In one of the typical river piers actual costs were as follows: for excavation $3.60 per cu.yd.; for concrete, including all overhead expenses, $4.86 per cu.yd., made up of forming ($1.82), mixing, pouring, transportation and placing ($2.06), heating and protection (98c.) The total cost of the cofferdam was $3,914.

For the concrete in the superstructure the figure of $10.20 per cubic yard, as bid, was slightly over the actual cost.

The Arrand Construction Co., Saskatoon, was the general contractor.

Temperature readings were taken during 1933 from thermometers buried in the arch ring in a pier and in the floor system. The range of air temperatures during the year varied from a minimum of 36 deg. below zero to a maximum of 103 deg. in the shade.

One of the general conclusions arrived at is the surprising effect of the temperature flow from the water in the river through the pier and up through 100 ft. of arch ring to the crown at an elevation about 75 ft. above the water. In February (Fig. 4) when the minimum air temperature was 36 deg. below zero, the roadway slab went to 30 deg. below zero, but the mean daily temperature at the center of the arch crown was never lower than 22 deg. below zero, nor that at the center of the springing tower lower than 10 deg. below, nor that at the center of the 72-in depth in the pier lower than 3 deg. above zero. Also, in the hot periods of the summer the temperature of the crown and springing sections did not get within about 20 deg. of that obtained in the floor system.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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A Timely Subject

REBUILDING OF BLIGHTED AREAS—By Clarence A. Perry. Cloth; 8½x11 in.; pp. 59; numerous halftones and linecuts. Published by the Regional Plan Assn., 400 Madison Ave., New York, N. Y. $2.

This discussion of the fundamental requirements of rebuilding blighted areas in our cities is particularly timely now when so much attention is being directed toward slum clearance and allied subjects throughout this country as well as abroad. The study, based on the neighborhood unit idea, takes up the development of a specific site that may be considered typical of large slum areas in most cities. Plans are drawn in considerable detail to show the possible integration of comfortable shelter, services for efficient living and opportunities for cultural and social advantages. Both the physical and financial aspects of the problem are covered.

The Seaway Favored

THE GREAT LAKES-ST. LAWRENCE DEEP WATERWAY TO THE SEA—By Tom Ireland. Cloth; 5x8 in.; pp. 223; photographs, maps. Published by G. P. Putnam's Sons. New York and London. $2.

Unbounded enthusiasm for the Great Lakes-St. Lawrence deep waterway speaks out from the pages of this book, even from the chapter headings, nevertheless it is well and, in some parts, convincingly written. Some stock arguments of opponents of the seaway are cleverly answered. For example, Mr. Ireland states that the oponents claim that the seaway would be injurious to the railroads contradicts another of their claims that it would have no justifiable use. But in his enthusiasm Mr. Ireland also falls in the same error when he attempts to picture the seaway as beneficial to the railroads and to most if not all of the country. He argues that when the lake ports become seaports the railroads will benefit from the greater movement of freight to those ports, but he disregards the fact that if any considerable part of our export trade is diverted from the Atlantic ports to the lake ports that much of the fixed railroad equipment serving the Atlantic ports will be put out of service. One of the most difficult questions to answer in connection with the proposed waterway and one carefully avoided by its advocates is whether, if it is used to the extent they claim it will be, the direct loss to certain industries through disorganization, loss of markets and changes in established channels of trade will be more than offset by the indirect gain to the country generally. Mr. Ireland does not answer it.

Bearing on Financial Matters

STOCK MARKET CONTROL—A summary of findings and recommendations of the security markets survey staff of the Twentieth Century Fund, Inc. 6 x 9 in.; pp. 209. Published by D. Appleton-Century Co., New York and London. $2.

During recent years, engineers, technologists and others whose major concern is the production and distribution of wealth have taken increasing interest in those business activities that have to do with traffic in bonds, stocks, mortgages and other symbols that represent that wealth or claims upon it. In "Stock Market Control" we have the results of a study made under the auspices of the Twentieth Century Fund, Inc. The survey of the securities market is designed to set forth in as clear and simple terms as possible how the security markets are organized and how they operate. In addition, it attempts to pass critical judgment on market practices and to suggest a constructive program for the regulation and control of the securities market.

The treatment is concise and lucid, and the style is swift and readable. Technical men who would acquire a working knowledge of the subject without the expenditure of much time on detailed technical descriptions of market practice can get just what they want from a couple of hours with this book.

New Problems in Transportation

INLAND TRANSPORTATION—By Sidney L. Miller. Cloth; 6x9 in.; pp. 822; tables and diagrams. Published by McGraw-Hill Book Co., New York and London. $4.

RAPID CHANGES in transportation have led Professor Miller to revise and expand his earlier work, "Railway Transportation," to cover motor, inland water, air and pipe-line transportation.

No adequate transportation system will just grow, Professor Miller states, nor will the place of each instrumentality be fixed by the relative cost of comparable services; an adequate system must be developed through a careful study of all pertinent facts. It is as the basis for such a study that Professor Miller has compiled and analyzed the facts presented in his book.

The book is divided into five principal parts. Parts I and II deal with transportation before the advent of railroads and with the development of railroads and railroad regulations. Part III relates to railroad services; Part IV is an analysis of the facts which the author hopes will indicate what is sound and what is inadvisable in public policy, and Part V is a discussion of the new forms of transportation. The concluding chapters are devoted to a discussion of progressive transports, the present transportaton problem and a national transportation policy. The latter takes up needed changes in railway legislation and public policy toward the newer agencies. Here Professor Miller joins in the recent recommendations of Railroad Coordinator Eastman that all forms of transport be put under the control of the Interstate Commerce Commission.

Structural Analysis by Elastic Theory

THEORY OF ELASTICITY—By S. Timoshenko. An Engineering Societies Monograph. Cloth; 6x9 in.; pp. 416; tables and diagrams. Published by McGraw-Hill Book Co., Inc., New York and London. $5.

REFINED METHODS for determining stress distribution in modern engineering structures, whenever used, have demonstrated their practical worth and indeed have been directly responsible for many advances in structural design. But the theory of elasticity upon which they are based is not widely enough understood; only a relatively few designers have brought their knowledge up to date. The fault has not been lack of available information but the absence of a concentration of information in one place, and an authoritative coordination and evaluation of it. This book of Professor Timoshenko's supplies these necessities and is an outstanding contribution.

The book gives engineers, in as simple form as seems possible, the necessary fundamental knowledge of the theory of elasticity. It begins, in the interest of simplification, with two-dimensional problems, in both rectangular and polar coordinates, permitting the reader to familiarize himself with the various methods used in applying the theory of elasticity. Three-dimensional problems follow. Typical chapters consider strain-energy methods (virtual work, least work, Castigliano's theorem), complex variables, torsion, bending of prismatical bars and wave propagation.

Such aids to elastic solutions as the photo-elastic method, the soap-film method and the electrical analogy are also outlined. Nowhere previously has the theory of elasticity been treated so completely nor with such evident intent to make it practical.

Miscellaneous Notes on Booklets and Reprints

INTERESTING DATA on the beginnings of the first engineering school in this country are contained in Engineering and Science Series No. 45, Rensselaer Polytechnic Institute, Troy, N. Y.

WATER AREAS — HOW TO CREATE THEM, is the subject of a pamphlet published by More Game Birds in America (a foundation), 500 Fifth Ave., New York City. The pamphlet describes various types of low dams to be used for such purposes.

INDUSTRIAL RESEARCH in 45 manufacturing organizations is reviewed with reference to administration in a pamphlet entitled The Control of Industrial Research, published by the Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York City.

A GROUP OF ARTICLES on a number of the best known suspension bridges is brought together in a new 130-page booklet of the John R. Roebling's Sons Co., Trenton, N. J. The articles are largely from *Engineering News-Record* and from the company's publication, *Wire Engineering*.

ADDITIONAL INFORMATION on the application of comparator measurements to mapping by aerial photography is given in "Supplemental Topics in Aerial Photogrammetry" by Earl Church, associate professor of photogrammetry, Syracuse University, Syracuse, N. Y. This is the sixth bulletin on the subject published by the university.

THE DESIGN OF HINGELESS ARCHES in which the effect of superstructure restraint is considered, has been prepared by A. Frangipani and is published as a 25-page pamphlet by *Le Constructeur de Ciment Armé*, 148 Boulevard de Magenta, Paris. The pamphlet is entitled "De l'arc élastique sans articulations et de sa liason au tablier dans l'application aux ponts."

ORGANIZING PROCEDURE for public low-cost housing is outlined in a new pamphlet prepared by the National Association of Housing Officials, 850 East 58th St., Chicago, entitled "Public Housing Surveys." It is intended as a practical handbook to guide local groups in determining what facts are relevant to demonstrate the need for low-cost housing, where the facts are available and how they may be obtained. Sample forms are given for gathering various types of essential data.

CURRENT PUBLICATIONS ON EARTHQUAKE ACTION is given in Bibliography of Seismology, Vol. X, No. 19, of the Dominion Observatory, Ottawa, Ontario, Canada. Closely related information is found in "Destructive and Non-Destructive Earthquakes in California and Western Nevada, 1769-1933," compiled by the U. S. Coast and Geodetic Survey, Washington, D. C.

DESIGN DATA FOR SPLIT-BEAM-FLANGE GIRDERS (WP girders) is contained in a 10-page booklet available from Weiskopf & Pickworth, consulting engineers, 45 W. 45th St., New York, N. Y. In addition to describing and illustrating the girders and their features of large capacities and shallow depths, half of the booklet is devoted to detail tables.

SILICOSIS is the subject of a pamphlet published by the industrial health section of the Metropolitan Life Insurance Co., New York. The pamphlet has been prepared by the company in view of the increasing prominence given to the effects of silica dust on the health of workers. It is intended to be a source of information for plant superintendents and foremen in departments where silica dust is present, and will be found of value in the construction field as it deals also with the dust problem in rock work. Copies may be obtained from the Industrial Health Section, Metropolitan Life Insurance Co., 1 Madison Ave., New York City.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE, 1934—Vol. 12. Flexible; 6x9 in.; pp. 790; diagrams and tables. Published by American Society of Heating and Ventilating Engineers, New York City. $5.

DYNAMIK DER STABWERKE—By K. Hohenemser and W. Prager. Paper; 6x9 in.; pp. 365; tables and diagrams. Published by Julius Springer, Berlin Germany. 34 RM.

GOTTHILF HAGEN—By G. H. Ottmann. Paper; 7x10 in.; pp. 193. Published by Wilhelm Ernst & Sohn, Berlin, Germany. 10.50 RM.

THE NILE BASIN—By H. E. Hurst and P. Phillips. Vols. III and IV; Board; 7x11 in.; pp. 715 and 287 respectively; tables and a large folding map. Published by Government Press, Cairo. Price P.T. 50 or 10 shillings. . . . *Data on gage readings and discharges, a continuation of earlier reports.*

Letters to the Editor

Engineer's Code

Sir—Although an expression of my reaction to your editorial, "A Fundamental Issue" (*ENR*, Dec. 7, 1934, p. 691), may be somewhat late at this date, still I cannot refrain from complimenting you on the stand you take, a stand that should be supported to the utmost by all engineers who wish to further the status of engineering as a profession and who are imbued with a desire to fight for the ideals that have been set up by Dr. J. A. L. Waddell and Dr. D. B. Steinman and many other consulting engineers who have constantly sought to keep engineering from sinking to the level pictured by Stuart Chase.

It may be a coincidence, but if those who are interested will go back some years I think that they will find it recorded that interests similar to those that are now opposed to the segregation of engineering charges, as provided for by the code, were opposed to the passage of laws providing for the registration of engineers. It is only natural that such interests should look with disfavor upon a code which seeks to segregate the cost of engineering from other items that go to make up the total expense connected with a finished project.

It must not be forgotten that the objectors to the public segregation of engineering costs are engaged in a business in which they act in many capacities—promoters, financiers, purchasing agents, shipping agents, constructors and often as managers and operators; and there is no reason to suppose that those who control and dominate the policies of these organizations are gifted with virtues of a higher order than business men in other lines of endeavor . . . shall we say bankers, industrialists and utility magnates?

I am sure that the public would look with disfavor on a physician that acted also as pharmacist, nurse, funeral director, grave-digger, officiating clergyman, landscape gardener, monumental architect, sculptor and stonecutter.

When it comes to facts, the truth is that the objectors to the code carry on a corporate business in which they employ engineers to work for them in one of its branches and that they make a profit on the work of such engineers, and hence get them on a competitive basis and for as low a figure as possible. In short, these organizations are in business to make money, and due to the fact that they do cover such a wide range of activities and are impersonal organizations, they have certain defects and weak spots that are absent in the practice of engineering as carried on by individuals or relatively small organizations of consulting and designing and supervising engineers, each member of which feels a keen personal responsibility and is more or less personally responsible to the client and to the profession.

Of course, if engineers are not interested in maintaining their professional integrity and entity, there is nothing

further to be said, and the objectors to the code will doubtless proceed to have it written in a form favorable to themselves. If, on the other hand, engineers do have professional ideals and wish to have the same public confidence and respect that members of other professions enjoy, then they must insist that engineering costs be segregated and treated as proposed in the code.

CHARLES JAY SEIBERT.

Rio de Janeiro, Brazil,
Jan. 12, 1934.

Geodetic Survey's CWA Work

Sir—Your issue of Feb. 15 contains an attack on the present CWA work being done by the Coast and Geodetic Survey. The views of the contributor who signs himself "Builder" are so diametrically opposed to one who is at least entitled to sign himself "Engineer" that they must not go unchallenged. "Builder" states that he is "surprised at the complacency of most private engineers who sit idly by and see the U. S. Coast Survey take all the bread and butter out of their mouths."

As an enginer whose firm does more surveying in Colorado than any other private firm, I wish to state that the present surveying work being done by the Coast and Geodetic Survey is work which I would never undertake in private practice. The development and application of the Lambert projection system to the state of Colorado is properly a duty of the Washington office, and the placing of field monuments under this system will be a welcome help to all private surveyors. Just as the government re-surveys section corners, as a city sets the points controlling block corners, so should the Coast and Geodetic Office supervise the present surveys.

"Builder" predicts that all the present work will be discarded. I heartily disagree. Some of it will be valueless, but if the work is continued and supervised by the Washington office, most of this work will be of very great value. My statement is that if this surveying work were attempted by private engineers in each state, there is a much greater probability of its being discarded as useless. The history of contract surveys is conclusive on this point.

The private engineer will welcome points from which he can determine his starting azimuth, his elevation and his latitude and longitude. Several months ago our firm was asked to give an accurate latitude and longitude for the new K.O.A. broadcasting station in Denver. The available information and starting points for performing this service were pitifully lacking. Since then we have had two other requests for similar data, and, speaking for one engineer in private surveying practice, I heartily welcome a continuation and completion of the present work of the Coast and Geodetic Survey's emergency control program.

Furthermore, half of the engineers finding work under CWA have been employed on Coast and Geodetic Surveys. It has been a godsend to the engineering profession.

FRANK H. PROUTY,
Partner, Prouty Bros. Engineering Co.

Denver, Colo.,
March 16, 1934.

* * *

Sir—I have read with a very great deal of interest the letter in your Feb. 15 issue entitled "The Geodetic Survey's CWA Work," signed by "Builder," also the reply of Captain Patton.

After 117 years of service by the U. S. Coast and Geodetic Survey and 55 years by the Geological Survey, the topographic mapping of our country was only 45.2 per cent complete as of June, 1932. Due to topographic changes, a great many maps made in the early days of these bureaus are now very much in need of revision, hence it is doubtful whether more than 35 to 40 per cent is really satisfactory for our present-day requirements. In addition to the vast amount of topographic mapping, unfinished or in need of revision, there are thousands of miles of state boundaries, tens of thousands of miles of county boundaries and millions of miles of township and municipal boundaries that have never been adequately surveyed, monumented and preserved through connections to Coast Survey triangulation. It can be said with a very great deal of certainty that surveying and mapping in our country have never kept pace with the rapid increase in population, wealth and land values. Under these circumstances, the present generation of land surveyors can look forward to an almost inexhaustible amount of work on which to earn their bread and butter.

Your correspondent states "The CWA work directed by the Coast Survey is surely a makeshift, and the plans and surveys will all be discarded." I do not believe anyone connected with this project in an administrative capacity believes that a temporary organization of men with varied experience can hope to equal the superlative efficiency developed by the federal bureaus through years of service. However, much useful work is being completed.

Your correspondent also asks: "Are our servants in Washington all as autocratic as the Coast Survey and the Geological Survey?" During the past few years I have had a great deal of correspondence with the Coast Survey in which much detailed information was requested. Without exception, these communications have been cheerfully and promptly answered with the data inclosed. I have also had numerous contacts with field parties in the past two years. During these visits the field officers have always been only too glad to show me, as well as other private engineers, their methods of field procedure. For efficiency of operations, willingness to cooperate with the public and courteous treatment to citizens the U. S. Coast and Geodetic Survey sets an example that many other federal bureaus might follow.

PAUL P. RICE,
Instructor in Civil Engineering,
Lafayette College.

Easton, Pa.
March 15, 1934.

RESOLUTIONS urging that the emergency survey work be continued, just voted by a conference of Maryland engineers, are typical of the views and action of engineering organizations in many parts of the country. American Engineering Council advances a specific proposal for a survey and mapping program, noted in our news pages this week, and an editorial endorsing this proposal will be found on another page. —EDITOR.

Bond Interest and Repudiation

Sir—In your March 22 issue I have read with interest the editorial "Wage Discrimination." Your sympathetic comments on the claim of the railroad unions suggest several queries, which I venture to set forth at the risk of being classed at once as a tory.

The chief investors in railway bonds, particularly those of high grade, are, to the best of my knowledge, our better-run banks and insurance companies, the depositories of the savings of millions of our thrifty self-respecting people. Should our banks and insurance companies be permitted or, in line with today's trend, be compelled to place the money of the depositors and policy holders in hazardous ventures?

Just how did the present generation of railroad employees come to find employment, except that the equipment and facilities they make use of were provided with money loaned for the purpose? Are they entitled to profit by denying the agreed return to the savings that provided their equipment? With repudiation a popular doctrine, are such things as living up to one's agreements entirely a thing of the past?

The construction industry, above all others, relies upon confidence in contractual obligations. What enterprise could be carried on with no faith in mortgage agreements or in construction contracts? It takes courage and enterprise in large amounts to make long-time commitments in a construction project, be it building, bridge, railroad or what not. Who would undertake such risks with the sacredness of contract impaired? Is the answer the government? Would the government borrow money for this purpose? And if so, would government obligations be considered binding? Or shall the direct step to confiscation be taken? Having arrived thus at socialism, who will accumulate further savings to be confiscated and used for further enterprise?

N. A. RICHARDS.

New York, N. Y.,
March 23, 1934.

MR. RICHARDS has misconstrued the meaning of the editorial. Repudiation was neither mentioned nor implied. The note merely pointed out that in some industries fixed charges are too high and that in fairness to labor it would be much better if this were not so. Briefly, the editorial urged more stocks and fewer bonds. —EDITOR.

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EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, J. I. Ballard, W. W. De Berard, N. A. Bowers.

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A Vote Against Earthquakes

BY THEIR VOTE to reject a $20,000,000 bond issue to rebuild and strengthen school buildings against earthquakes, the citizens of Los Angeles give the world a surprise and leave their own year-old major problem of public safety unanswered. In effect, the action of the electorate is a vote to gamble against the chance that earthquakes will occur. It also is a classic example of the swift ebb of public demand for betterment even within a few short months after a serious disaster. Only recently the public clamored for safe schools, but when it came to action the voter's pocketbook was a weightier factor than even his own children's safety. In the light of the Los Angeles experience it is easy to appreciate how great an educational effort must be put forth to bring about action on even the most urgent public improvements, whether the removal of firetraps or protection against storm, earthquake or flood.

Clearness Still to Come

JOINED WITH appreciation of the President's success in settling the threatened automobile strike there is bound to be disappointment over his failure to clarify definitively the collective-bargaining clause of the Recovery Act. What he did say about this clause constitutes some progress; but it might have been greater. The NRA and the Labor Board have kept the clause involved in obscurity. The President does not bring much more light into it, for he omits to say whether bargaining in industry must be or may be collective, whether the individual worker and the minority group are subject to majority control, whether the employer or his employees or still others are to decide on hiring or firing. Until these matters are made clear neither management nor workers will feel secure. Especially serious is this situation for the construction industry, which is just about to enter on the responsible task of arriving at area agreements on labor conditions.

A Rebuilding Policy

CONSTRUCTION, as well as all other business, is interested in the policy of "Rebuild America" that is said to be the newest outgrowth of Washington planning. Its elements are financing of capital-goods manufacture and stimulation of construction. It would be easier to judge of the seriousness of purpose back of it if an honest effort had been made last summer to follow through with the $3,300,000,000 public-works program. That program was scuttled, however, and the results are before everyone's eye in the pitiful atteunation of its job results. Accident, design or mismanagement removed the program from its place in the recovery campaign and instead made it a means for carrying on a process of reform worthy in itself perhaps but bought at the cost of continuing mass distress and pauperization. In place of the direct-acting construction plan, a system of artificial wage-raising was depended upon as a recovery device. It is this system, or rather the way in which it was administered, that has led to the present impasse, when rioting strikers everywhere turn their backs on jobs eagerly sought a few days earlier. It has led labor ornagizers to boast that they seek neither wage nor working-time improvement, but power. It has brought about the whole amazing and insane confusion that causes even a mayor to badger hotel keepers in the interests of striking waiters and hold a sheltering arm over taxicab union mob banditry. It is time indeed to turn back to constructive procedures; time to bring the heavy-goods industries back to life; time before all to put a really effective push behind a construction program. For through the latter architects, engineers, contractors, manufacturers of machines and materials, and the entire chain of industry which these draw after them can find the normal and helpful activity on which our national existence is built.

Sewage-Treatment Data

ON ANOTHER PAGE of this issue there appears a short article giving in condensed form the salient design characteristics and performance data of the sewage-treatment plant at Decatur, Ill. It inaugurates a series of articles to be published at frequent intervals giving similar data from other places. There are few fields in public facilities in which design practice is less crystallized than in sewage treatment, or in which the service value of the facility is more directly dependent upon competent and careful operation. The design of sanitary facilities is not wholly subject to mathematical determination, and to a great degree of adequacy of physical provisions can be judged only in the light of actual performance. From the standpoint of the engineer, therefore, the publication of performance data, correlated with design characteristics, should be of special value. Data from a single plant may be of limited application, but data from a large number will usefully answer many important questions.

Continue Mapping

STRONG EFFORT to have mapping work continued as part of the federal government emergency work program is being made by American Engineering Council. We do not need to argue before engineers the great importance of completing and amplifying the federal base map network, but all engineers are not convinced that the control survey work begun last winter by CWA men under the direction of the Coast and Geodetic Survey is of sufficient value to warrant its continuation. The director of the Survey has stated very strongly that it is. Similar views are expressed by engineers throughout the country who have studied the work of the CWA survey parties at close range. What now needs to be done as an essential element of the recovery campaign is (1) to re-establish these parties to continue laying down control lines, (2) to parallel this work by a comprehensive program of airplane photographic surveying, and (3) to prepare the maps required in practical planning and construction operations. This project will supply needed basic information; it will give work to many engineers. The Council's effort to have the work continued warrants wide support. It must have wide support if it is to succeed.

Time to Clean Up

EARLY in January the Civil Works Administration started a demolition movement, to utilize CWA labor for clearing away the many unsafe and hopelessly obsolete buildings that disfigure our cities and even our country districts. For various reasons the movement did not make much progress. Now it is being resumed vigorously as a leading activity of the work-relief program that supersedes the CWA. The campaign offers the nation's communities one of the greatest opportunities of many years, the opportunity to clean up.

It is an opportunity not because such demolition is too difficult and costly for ordinary times, but because *it has not been done and will never be done* systematically and thoroughly except under the impulse of a general campaign and the unparalleled inducement of free labor.

When Langdon W. Post, tenement house commissioner of New York City, is able to say in a public address, "There are 67,000 old-law firetrap homes that we know of in this city, that have existed for 35 years at least"; and when it is realized that these old-law tenements, so-called, are the buildings which the Tenement House law of 1901 was written to abolish, it is not hard to understand how vast an opportunity for improvement by demolition is at hand. And New York is not unique among cities; it merely has better statistics.

No one familiar with the facts of city development can doubt that the value of the betterment created by a comprehensive demolition campaign is greater beyond compare than its cost. The present time favors such a campaign in a way that has not been known within a generation or two. At a time when vacancies are high and most properties are unprofitable, the true valuelessness of worn-out and ruinous structures is apparent.

In the forefront of the campaign, of course, is the purpose to provide productive work for unemployed men. But we would make a sorry showing if we did not apply this purpose to best advantage by so planning and conducting the campaign as to accomplish a truly effective clean-up. Essential to this result is a comprehensive survey of every city or region that takes part in the campaign, directed toward locating all structures that should be demolished and toward finding the readiest means of initiating the demolition. In many cities this necessary preliminary work is already far advanced; it needs to be taken in hand promptly everywhere, in clear recognition of its importance to the community, so that a well-ordered program of work can get in motion quickly.

Procedure details have already been worked out by the Relief Administration at Washington, with the aid of experience contributed by a conference of experts and city officials called together by the Administration last week. That the plan contemplates making use of the experience and facilities of existing wrecking contractors is one of its commendable details. The demolition project gives express recognition to the sound idea of utilizing existing managerial and directing skill through a normal bidding and contract method—a course of action that is constructive because it works directly toward resumption of normal industry practice.

Thus, at no cost to the local communities, but at the expense on their part of energetic and enthusiastic cooperation in planning and prosecuting the demolition campaign, a far-reaching improvement possibility is before them. In taking advantage of the opportunity they will serve the double purpose of creating a permanent improvement and helping their own citizenry in reducing unemployment. The combined objective is worth the support of civic bodies, real estate interests, engineering and city planning groups, as well as the citizenship at large.

Shall Wasted Effort Continue?

LET US BE realistic about it. The CWA program comes to an end on April 1, but the work-relief program that follows will be with us for many months. Far too many people are still without employment, and without early hope of it, for public employment enterprises to be abandoned so soon. Indeed, there is a strong likelihood that the approach of next winter will again be the signal for feverish activity to put more men to work on public projects.

Somewhat dramatically, last November, the Civil Works Administration movement came into existence as a sequel to several years of uncoordinated local activity in unemployment relief. Those in charge of it, largely social welfare workers, promptly called on local engineer officials to select the projects to be undertaken and to supervise and direct the actual work. No preparation had been made for such responsibility. Plans, projects, schedules and all the other necessary preliminaries did not exist. The consequences of an improvised program were an appalling amount of waste motion and misdirected effort. Even as a builder of morale the program fell far short of possible accomplishment. Witness the current CWA strike movements.

How can the wastefulness that has featured work relief be avoided? By substituting preparedness for improvisation. The time to start preparing is now, and it must be done by the engineer. No one else can do it.

There is no dearth of proper work. A survey of any city in America will reveal needs for improvements that are suitable for relief-employment enterprises. Quite typically, the physical facilities and equipment necessary for urban life are ancient and unfit to meet emergencies. Rutted streets, disintegrated curbs and sidewalks, broken-down sewers, rubbish-heap river banks are plentiful and give our communities a run-down-at-the-heel appearance. Acres and acres of rotting wrecks of firetrap houses represent a liability from which no city is free.

Suitable projects must be selected. Those that can safely be deferred until cold weather must be designated. For each, there must be made an estimate of the employment provided and of the tools, materials and direction required. Selected projects must be coordinated with each other and with the public improvements of a more ambitious nature that are undertaken by other than work-relief methods. Schedules of activity must be prepared, in regard to both the sequence of projects and the assignment of directing personnel. Trained men for the direction of operations must be drafted from existing organizations and must be familiarized with their probable coming assignment.

No official notification will be given of the need for this preparation. It is entirely the responsibility of local engineers to perceive the implications in the present situation. Their participation in the direction of public employment enterprises has not ended. If they will, they can avoid the wastefulness of the past and, through the labor of those in their charge, create permanent values for their communities.

CURRENT NEWS

Types of Work for New Urban-Works Program Outlined

SIX FIELDS OF WORK have been suggested by Federal Emergency Relief Administrator Harry L. Hopkins, as a guide to state and local relief organizations in planning the programs of the new urban-works divisions which replace the CWA program. Employment of needy persons would be distributed as follows: 3 per cent planning projects, 30 per cent public improvements, 15 per cent demolition and housing, 15 per cent production and distribution of goods needed by the unemployed, 7 per cent public welfare, health and recreation service and 10 per cent education, arts and research. The 20 per cent reserve may be distributed among any of these fields as conditions warrant.

Work of planning is intended to serve in the selection of projects in the other fields and will provide employment for engineers, architects, statisticians and other professional, field and office workers. Planning and coordination of projects with larger plans for local and state improvement are stressed by Mr. Hopkins. He recommended that the administrative staff in each state and in the larger cities and counties include an engineer to ascertain what plans and planning bodies now exist in the fields covered by the several types of projects, outline surveys to establish or complete such plans, and recommend whether major projects proposed for undertaking by the works divisions are consistent with such plans. Particularly did Mr. Hopkins emphasize the point that plans, specifications, and engineering and organization detail and instructions be prepared well in advance of starting projects.

Improvements to public property would include work identical to that which was carried on by CWA. Listed are the improvement and extension of waterworks, sewer systems, grade crossings, limited highway and street work, municipal power lines and power plants and airports. Improvement of public buildings, such as schools, auditoriums, community houses, city halls, and institutions would also be in this field. All projects must be approved by state administrations. Eligibility for relief of professional, technical and skilled workers may be made in cooperation with professional and labor organizations. No person may be employed less than 54 hours a month, nor less than 3 days in any week. Those whose need is less that this will be carried on direct relief rolls.

The rural relief program announced by Administrator Hopkins March 23 includes work projects which may be a continuation of "unfinished-preferred" CWA projects now under way but payment for work will be made in kind instead of in cash. Work will be valued at the prevailing scale, with a minimum of 30c an hour as credit against advances of food or other consumable items or for capital goods for self-sustenance purposes.

Reallotment in PWA Loans Results in Releasing $369,000

Reallotment of PWA funds, as announced by Administrator Ickes, provided an increase in four and a reduction in 16 non-federal projects. The net change in the PWA funds will be to release $369,000 for reallotment to other projects now on the waiting list.

The increase in loans and grants totaled $26,750, and the decrease totaled $427,000, with one additional increase in an outright grant. Among the important changes in allotment was a reduction in the Madison, Wis., loan and grant from $912,200 to $750,000 because of a change in the plans for the project which made the smaller allotment sufficient. A $918,000 loan and grant to Orange County, Calif., for harbor improvement was reduced to $875,000, because the county was able to obtain the difference of $43,000 from other sources, and the loan and grant of $4,198,000 made to Fort Worth, Tex., for the construction of school buildings was reduced by $31,000 because of the limitations for the amount of bonds which the city could issue to secure the loan.

Consider Combining PWA and RFC to Aid Public Works

COMBINING the resources of the Public Works Administration and the Reconstruction Finance Corporation to carry forward the construction of municipal public works is receiving serious consideration by both agencies. The proposal is based upon the expectation that the budget of the next fiscal year for public works will not be as large as the huge appropriation for the current year which has provided allotments of $650,000,000 for non-federal projects.

Self-liquidating projects would be eligible, as at present, for outright grants by PWA of 30 per cent of the cost of labor and materials but the remainder would be advanced by RFC. In most cases, the PWA now finances the entire cost, by purchasing bonds for the 70 per cent in excess of the grant. It is this part of the ar-

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Continuing of U. S. Mapping Program Urged by Engineering Council

A MEMORIAL URGING continuation and vigorous prosecution of the emergency survey and mapping program has just been issued by American Engineering Council. Pointing out that only one-fourth of the country is adequately mapped, and that at the present rate of progress it will take nearly a century to complete the survey of the country, the Council emphasizes the sudden increase in the need for adequate surveys and maps brought about by the Government's emergency activities, both as to planning and as to construction. The Council therefore asks for inclusion of a survey and mapping emergency program in the next public-works appropriation, to continue the control work begun by the Coast and Geodetic Survey as a CWA project and to extend it to full surveys and mapping.

Under the requested program a large number of unemployed engineers would be utilized, says the Council. This effect is declared to be particularly important because termination of the CWA winter program is depriving thousands of engineers of the employment on which their very existence depends, and these men cannot be absorbed in the near future by business and industry.

An appropriation of $17,550,000 is proposed to meet the cost of this program. To assure efficient utilization of the money it is recommended that there be established by executive order a temporary surveying and mapping authority under the Public Works Administration, the authority to comprise a representative of the Geological Survey, a representative of the Coast and Geodetic Survey, and an engineer from without the federal service. This authority is to have the cooperation of the two survey bureaus named, of the air services of the War, Navy and Commerce departments for the execution of aerial photographs and of all federal agencies that have instruments and equipment available.

Present Survey Needs

In setting forth the present critical situation as to survey needs, the Council points out that the Temple Act of 1920, which authorized completion of the map of the United States within 20 years, has never been given practical effect by suitable appropriations.

"Progress subsequent to 1926 has been substantially the same as that which had prevailed for years prior to that date. Council strongly believes that there is urgent need for adoption of a large-scale energetically conducted mapping program, which in the shortest possible time will furnish information to meet present urgent needs and thereafter will proceed at a more moderate rate, which, however, will be adequate to complete the mapping of the country with the possible exception of the contouring in little more than a decade.

"Within the past few months there has developed within the federal government a sudden and unprecedented need for surveying and mapping in the United States. Geographic data are essential

to the coordinated large-scale, long-range planning which occupies such a prominent place in the new economic order visioned by the President. Each of the many agencies now engaged in the execution of some detail of those great plans finds that it needs maps to derive information essential to its work. This need is certain to continue and increase."

To demonstrate the ready possibility of carrying on the proposed survey work as an emergency project the Council cites the recent CWA project of local control services:

"In this instance, where speed was particularly important, the survey, within two weeks after undertaking the project, had organizations built up and functioning effectively in each of the 48 states, and within about a month had some 10,000 men employed."

The proposed activities of the surveying and mapping authority are not intended to produce all the various types of maps required by the federal government and the public. The first step is to be the production of large-scale work sheets from both airplane and ground surveys, rapidly and boldy drawn in a type of drafting which the average engineer can readily accomplish. Contouring is to be done at this time only where federal needs require. It is proposed that the organizations conducting the local control surveys under the CWA project should be taken over or reestablished in substantially the same magnitude as of Feb. 15.

The cost of the work, covering an expected period of two years, is estimated as follows:

Operation	*Cost per sq. mile*
Photography	$2.75
Control (complete)	12.00
Field inspection	2.00
Compilation of map 1-10,000	20.00
Compilation of map 1-20,000	10.00
Reproduction per 1,000 sheets	.75
Total, 1-10,000 scale	37.50
Total, 1-20,000 scale	27.50

Assuming with respect to the 540,000 square miles that it is estimated could be mapped within the proposed emergency survey period that 50 per cent is mapped on a scale of 1-10,000 and 50 per cent on 1-20,000, the total cost of the surveying and mapping is computed as:

270,000 sq.mi. at $37.50	$10,125,000
270,000 sq.mi. at $27.50	7,425,000
	$17,550,000

TVA Contracts To Serve Power to Nine Cities

Contracts to serve TVA electricity to nine cities with a population totalling 200,000 have been signed by the Tennessee Valley Authority. Heading the list is Knoxville, which has already been granted a loan by the PWA to construct distributing lines. The city's offer to purchase existing facilities having been turned down, officials propose to draw plans for a new system. Other cities include Decator, Florence, Sheffield, Tuscumbia, and Russellville, Ala.; Pulaski, Tenn.; Amory, Miss.

Demolition as Work-Relief Project Discussed at Washington Meeting

DEMOLITION OPERATIONS to be carried on in a countrywide campaign as a major activity of the coming work-relief campaign of the Federal Emergency Relief Administration were discussed at Washington on March 23 by a conference of housing and wrecking specialists, city officials and others called together for the purpose by Administrator Harry L. Hopkins. Demolition work is an important item in the program of suggested work-relief projects prepared by the FERA last week as a guide to local authorities in carrying on the relief activities following the termination of the CWA work with the end of the current month. John M. Carmody, chief engineer of the work division of the FERA was chairman of the conference.

Jacob Baker, assistant administrator, opened the conference by saying that demolition is the forerunner of both rehabilitation and new building. "We happen to be in an advantageous position to expedite removal of useless and insanitary buildings. We have manpower available. We know that by using their labor to remove eyesores, firetraps, and disease-ridden slum dwellings we improve our towns and cities at once. It is highly desirable that our spring housecleaning program this year should include a widespread municipal housecleaning of this larger sort." He asked the conference to concentrate on devising a procedure by which demolition may be quickly gotten under way.

Demolition activities were proposed originally in a circular to state CWA administrators on Jan. 8, but little progress has been made up to now in getting it under way. With the transfer of CWA work to the local relief administrations on April 2, however, it is planned to put to immediate use the experience gained under CWA as to what are useful projects and how to initiate and operate them.

Mr. Baker emphasized the desirability if possible of taking competitive bids on demolition work, the labor to come from relief rolls, but the superintendence, liability insurance, trucking and other services to be provided by experienced wrecking contractors, who would be compensated from the salvage.

A significant statement in Mr. Baker's address was, "We can't say what the form of the work division will be six months from now, but it is to be expected that the work system will continue as long as this great social responsibility confronts us."

Leon M. Gurda, inspector of buildings, Milwaukee, reviewed his city's experience in systematic demolition during the past six years. Condemnation was used freely in cases of unsafe and nuisance buildings. In most instances the owner removed them, but some were removed by the city. Since January a force of 52 unemployed architects under the CWA has been making a survey of dangerous, dilapidated or insanitary structures within the fire limits, a matter of special importance because 133,000 out of 170,000 buildings in Milwaukee are of frame construction. To date a survey of 300 blocks out of 2,200 has been completed; 420

NATURAL AMPHITHEATER IN ARIZONA IMPROVED BY CCC

In a picturesque setting on a desert hillside, 5 miles from Phoenix, Ariz., a Civilian Conservation Corps unit has improved a natural amphitheater setting, as shown. It has been estimated that the work done would have cost the city or the state about $30,000. This project is the only one of the type carried out by the CCC.

buildings out of 860 have been rated as Class 4 or 5, respectively bad and unsafe, and extremely bad. A total of 4,000 buildings in these two classes is expected, aside from masonry buildings that require repair or condemnation.

W. S. Haldeman, demolition project engineer of the Illinois Emergency Relief Commission, Chicago, and John R. Fugard, Chicago, described conditions in that city, where the demolition program was started recently. Six public buildings are now being removed and it is expected to start soon on a number of private buildings offered by owners. All work has been sublet to wrecking contractors, the CWA furnishing the labor; a safety supervisor and engineer inspectors are employed. Compensation insurance has been carried by the CWA and will be continued by the state, while liability is provided by the contractors in the name of the Metropolitan Housing Council.

New York conditions

Langdon W. Post, Tenement House Commissioner, New York City, reported three schools being taken down. The city is the largest owner of run-down tenements, and these are now being vacated and many of them demolished. Meetings of owners of obsolete tenement property are being called, and out of the first group of 250 brought together there were 75 who were willing to demolish. The Board of Taxes and Assessments has agreed in such cases to reduce the 1934 assessment. The wrecking contractor bids for the material and furnishes supervision and trucking, etc.

Ernest J. Bohn, member of the Cleveland City Council, reported that no demolition has yet been done in his city. Joseph Wolf, Detroit Commissioner of Buildings and Safety Engineering, spoke of the rapid deterioration of vacated buildings through vandalism. Such buildings are watched by his department, and when they become dangerous the Council is requested to order the department to wreck them. There has not been a single comeback.

David S. Bosley, wrecker, Chicago, proposed holding down the accident hazard by using wrecking men from unions, but chairman Carmody declared that it is vital to utilize unemployed men on this work even though it may be necessary to adopt present managerial skill to the new conditions. Joseph P. Tufts, executive director of the Pittsburgh Housing Association reported that extensive surveys are being made of delinquent properties and physical conditions of structures in slum areas. A board has been formed by the fire, building, sanitation and law departments to direct demolition. A. B. Evans, Pittsburgh building inspector, reported that about 100 buildings have been marked for demoltion, mostly single houses, aside from some sixty already removed this year.

John S. Shetler, CWA Administrator, Toledo, stated that salvage in his city must be retained as all and more is required from necessary housing. CWA labor only is used. A safety man is placed on every job and there has been only one accident.

Bernard J. Newman, executive director of the Philadelphia Housing Association, reported that surveys in certain areas showed five houses per block to require demolition. He also suggested a repair program as the only way to provide low-income housing, but George L. Sogg, Cleveland, held that this is not proper CWA work.

Following the discussion four separate committees took up the subjects of surveys and planning, operating procedure, legal procedure, and safety and insurance. The reports of these committees were brought together in an evening session and were approved as elements of a final memorandum of recommended procedure to be prepard by the FERA.

Demolition and rehousing

Active further discussion developed on the relation between demolition and rehousing. The fear was expressed by a number of speakers that if extensive demolition work is done it will have a severe reaction on the housing shortage that is now accumulating and will soon be felt. Statements by the representatives of various cities supported the claim that a housing shortage potentially exists even now, and that with doubling-up eliminated the present vacancy is less than 5 per cent or in some places even negative. Several speakers suggested government housing construction by CWA labor, but Joseph Wolf of Detroit and others strongly opposed such procedure.

While housing was not a recognized part of the conference subject, chairman Carmody forecast that in all probability demolition and housing construction will correlate themselves and that both will go on. It was the consensus of opinion that, in the words of Alfred Stern, Chicago, the program should drive ahead with demolition and let housing follow. However, it is essential to proceed to replan the areas vacated by demolition without delay. This point was recognized in the report of the subcommittee on planning and surveys in a recommendation that information on demolition operations be made available to all city departments including the planning department, so that the cleared areas may be taken into consideration in connection with all city services and activities.

City License Tax on Private Utilities Declared Legal

Municipal license taxes imposed by Seattle, Wash., on the Seattle Gas Co. and the Puget Sound Power and Light Co. were declared valid by the U. S. Supreme Court. The companies, which compete with municipally owned utilities, contended it was unjust discrimination, since the city-owned plant did not have to pay the levy. Under state laws, the municipality fixes its own power and light rates and the companies contended they could not escape tax burdens by appealing to the state for permission to increase rates, because they were forced by competition to sell at prices asked by the city.

The Supreme Court decision, delivered by Justice Stone, held that a city may constitutionally engage in business carried on by private enterprise, and compete with private business. It declared that the city was not required to abstain from taxing property conducted by a private company because it was itself engaged in the business and did not tax itself.

Code Authority Plans Nominations For P and A Board

THE CONSTRUCTION CODE Authority at its meeting in Washington March 23, decided on a partial list of nominations of employer representatives to the National Construction Planning and Adjustment Board for submission to the Industrial Advisory Board of NRA which makes the selections, subject to the approval of the Administrator.

Detailed consideration was given to the many requests from local communities for delegation of authority to administer the code, locally, or to serve as accredited sources of information about the code. Some of the groups requesting such recognition are established local organizations, such as builders' exchanges, building congresses, or local construction leagues, while others are newly formed councils comprising the local members of sponsors of the Construction Code. In general, their requests have been made without the understanding that administration of the Code is expressly delegated to the divisional code authorities as established, each of which is to administer Chapter I and its divisional chapter nationally, regionally and locally. Coordination of local divisional administration must follow establishment of divisional administration.

In divisions of the industry for which chapters of the Code have not yet been approved, the national trade association sponsoring the chapter will act as an agent of the Construction Code Authority in enrolling employers. This procedure, required by an order of the Administrator, is a necessary preliminary to organizing local administration and will assist in disseminating information regarding the Code in all divisions of the industry.

The meeting considered the executive order of the President, March 14, requiring all bidders to comply with the applicable approved Code of Fair Competition. Compliance procedure is being developed by NRA and the respective Federal Departments. The PWA has just issued a revision of Bulletin No. 2—Non-Federal Projects, requiring the use of Form No. PWA 61 (revised March, 1934), otherwise bids will not be received. The revised Form 61 will shortly be available through PWA State Engineers or the PWA offices in Washington, D. C.

The executive order is considered a highly important development and if the lead taken by the Federal government is followed by states and local subdivisions on projects involving state or local funds, many problems now arising under the Construction Code will be solved.

During the week, two additional chapters have been approved: Chapter IV, Elevator Manufacturing Division, and Chapter V, Cement-Gun Contracting Division. Other chapters for the Roofing and Sheet Metal Contracting Division, Electrical Contracting Division, Mason Contractors Division, Tile Contracting Divison, and Plumbing Contracting Division are progressing rapidly to final approval.

Protest has been made to the authority by the Associated General Contractors against the proposed code for the River and Harbor Improvement Industry, which

was heard at public hearing as separate from the Construction Code. It covers dredging, land reclamation, and levee construction by dredging, marine and subaqueous work in rivers, harbors and waterways, and maintenance and improvement of rivers, harbors and waterways. It is understood that the Construction Code Authority will protest this code as separate from the Construction Code on the basis that the work covered is included in the definition of the Construction Code and such a separate code would defeat the efforts of unification of the industry which have the approval of the Administrator and the President.

Despite protest by the authority, approval has been given to the Machinery and Allied Products basic code, under which such erection or installation, if made by the manufacturer, is not subject to the Construction Code. It is reported that the two industries are conferring in an effort to agree upon an amicable solution of this conflict.

The second meeting of the Divisional Code Authority for General Contractors was held in Washington on March 24. Progress was made in development of regional and local administration in this division, adoption of application form and procedure for registration of constructon work and services. Offices have been established in Room 356 Munsey Building, Washington, D. C., in charge of Louis W. Hickey, executive manager. Mr. Hickey, who is president of Hickey & Co., building constructors, Dallas, Texas, is prominently identified with construction activities in Texas. He is past president of the Texas branch of the Associated General Contractors, and past president of the Dallas Chapter.

Filtration Plant Enlargement To Start at Niagara Fall

Enlargement of the filtration plant at Niagara Falls, N. Y., made possible by a PWA loan of $345,000, has been announced for immediate start by William D. Robbins, city manager. The project provides for doubling the capacity of Filtration Plant No. 1 and abandonment of Plant No. 2, except for emergency service. The capacity of the enlarged plant will be 54 million gallons daily.

PWA Allotments For 55 More Non-Federal Projects

FIFTY-FIVE small non-Federal PWA projects which will provide 14,000 man-months of direct employment in 23 states were alloted funds according to the latest report by Administrator Ickes. Total amount of the allotments is $3,408,000. Although the entire original PWA fund has been exhausted by previous allotments, the money represented by this new allocation was obtained by rescinding allotments made for projects which the municipalities were unable to put into the active stage.

One of the rescinded allotments is a loan and grant of $1,650,000 to Onondaga County, New York, for sewer construction. The county recently issued $2,000,000 of bonds for relief purposes and the board of supervisors decided further debt should not be incurred. Another allotment rescinded is a loan and grant of $1,035,000 to Hibbing, Minn., for streets, sewage disposal plant, extension of the water system and other improvements to city-owned property. The required bond issue was defeated at a recent election. A third rescinded allotment is a $365,000 loan and grant to Catskill, New York, where the people at a recent election voted against issuing bonds for constructing a new school building.

Upon receiving information that the money allotted for these three projects and several other smaller ones would not be used, PWA promptly reallotted these funds. All of the allotments announced today were made on the condition that the recipients execute promptly the necessary bond contracts and grant agreements and begin construction promptly. All applicants stated that work can start promptly. The individual allotments are listed in the accompanying table.

Power allotments

Financing for electric power plants provided by PWA funds now totals $128,860,000. Of this total, $104,160,000 will be spent by the federal government and $24,700,000 has been allotted to 50 non-federal projects. The federal projects will be owned and operated by the federal government. The non-federal projects will be constructed by local governmental subdivisions which are public bodies so that the projects will be publicly owned and operated.

The Corps of Engineers is building two of the federal projects which will combine flood control and river navigation improvement with power development. These are the Bonneville dam on the Columbia River, 40 miles from Portland, Ore., and the Fort Peck dam on the Missouri River in eastern Montana. The bureau of reclamation will carry forward three major developments: (1) Grand Coulee Dam on the Columbia River; (2) the continuation of the Boulder Dam project, and (3) the Seminoe unit of the Caspar-Alcova project in central Wyoming. The first two of these projects will rank as the largest hydroelectric plants in the country.

Non-federal power projects

Two of the non-federal projects are regional in character and the others are municipal plants. A number of the allotments to municipalities were made for improvements or additions to existing power and light plants. Both of the regional developments are in Nebraska: The Loup River project, an exclusive power development, has received an allotment of $7,300,000 and the Platte River project, for which $7,500,000 has been allotted, combined irrigation with power development features.

Two of the municipal allotments were made to Alabama towns to enable them to bring power from the government plant at Muscle Shoals and distribute it locally. Among the large municipal allotments are a loan and grant of $1,250,000 to Augusta, Ga., for a hydro-electric plant; a loan and grant of $2,600,000 to Knoxville, Tenn., for a central substation and distributing system; a loan and grant of $738,000 to Fort Collins, Colo., for a generating plant and distribution system; and a loan and grant of $700,000 to Moberly, Missouri, for a generating plant and distribution system. The complete list of non-federal power allotments to date totals about 50 projects.

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

Locality	Loan and Grant or Grant	Type	Amount
Summerton, S. C.	L. & G.	Waterworks system	$37,000
Pittsboro, Ind.	L. & G.	Water distribution	12,000
Parsons, Tenn.	L. & G.	Waterworks system	90,000
Hominy, Okla.	L. & G.	Distribution system	150,000
Emory, Texas	L. & G.	Gymnasium	5,600
Olcott, N. Y.	L. & G.	School building	462,000
San Patricio Co., Texas	G.	Highway	31,800
Henrico Co., Va.	L. & G.	Waterworks system	73,000
Fulton Co., Ga.	L. & G.	Jail building	155,000
Lawrenceburg, Tenn.	L. & G.	Sewer system	185,000
Lake Placid, N. Y.	L. & G.	School building	300,000
Dermott, Ark.	L. & G.	Hospital building	85,500
Winona, Minn.	L. & G.	School building	298,000
Rome, N. Y.	L. & G.	Street repair	81,000
Beaver Meadows, Pa.	L. & G.	Sewer system	40,000
Covington Co., Miss.	L. & G.	School building	2,400
Tarboro, N. C.	L. & G.	Waterworks system	200,000
Bedford, Ind.	L. & G.	Waterworks system	79,000
Herndon, Kans.	L. & G.	Waterworks system	30,000
Arlington, Vt.	G.	Heating system	1,300
Collinsville, Ill.	G.	Street repairs	17,400
Lawrence Co., Miss.	L. & G.	School building	23,500
Yuma, Colo.	L. & G.	Water system	10,000
Chester Co., Pa.	L. & G.	School building	16,800
Ellis Co., Texas	G.	School building	900
Irondale, Ala.	L. & G.	Sewage system	87,000
Virginia, Minn.	L. & G.	Hospital building	294,500
Vance Co., N. C.	L. & G.	School building	16,000
Schuylkill Co., Pa.	G.	School building	44,000
Hutchinson, Minn.	G.	Water system	1,900
Ida Co., Iowa	G.	Highway construction	22,500
Chickasaw Co., Miss.	L. & G.	School building	10,000
Okoboji, Iowa	L. & G.	Waterworks system	31,000
Lee Co., Iowa	G.	Field house	2,800
Harrison Co., Iowa	G.	School building	10,800
Union Point, Ga.	L. & G.	Waterworks system	38,000
Worth County, Iowa	G.	Highway construction	13,700
Worth County, Iowa	G.	Highway construction	11,500
Glencoe, Minn.	G.	Sewage disposal plant	10,600
Lucas, Ohio	L. & G.	Waterworks system	22,000
Prosperity, S. C.	L. & G.	Waterworks system	45,000
New Canada, Minn.	G.	School building	11,400
Litchfield, Minn.	G.	Electric power plant	18,000
Heron Lake, Minn.	G.	Waterworks system	1,900
Bremer Co., Iowa	G.	School building	15,200
Ste. Genevieve, Mo.	G.	Highway bridge	3,800
Knoxville, Ill.	L. & G.	Waterworks system	23,000
West Union, W. Va.	L. & G.	Waterworks system	13,000
Ramsey Co., Minn.	G.	School building	4,400
Watertown, Minn.	G.	Sewage treatment plant	2,500
Jackson Co., Mo.	G.	School building	5,700
Tomah, Wis.	G.	Sewer system	2,500
Lake Geneva, Wis.	L. & G.	Water plant	30,000
Two Rivers, Wis.	L. & G.	Power plant	247,000
Itasca Co., Minn.	G.	Bridge repairs	1,400
		Total	$3,408,300

Los Angeles Turns Down Bond Issue to Reconstruct Schools

Proposed bond issues totaling $20,411,283 for the rehabilitation of schools in Los Angeles, Calif., were defeated in an election March 20. The rehabilitation was declared necessary to repair damage caused by the earthquake of Mar. 10, 1933, and to effect structural changes that would be a safeguard against possible earthquake damage in the future. Three issues were submitted, elementary district, $10,839,037; high school district, $9,416,123; junior college district, $156,123. Each of the proposed issues received a majority vote, but each lacked the necessary two-thirds majority to carry. The city board of education has available $11,158,000 to carry on rehabilitation work, and consideration is now being given to the allocation of this fund.

Consulting Engineers Urge Technical Advice on CWA Work

More extensive use of technical engineering service in the carrying on of CWA work, or its future continuance, and permission that design and supervision be eligible for CWA projects, when public safety was involved, provides the basis of a resolution adopted by the Council of the American Institute of Consulting Engineers. The resolution was forwarded to Administrator Harry L. Hopkins, and American Engineering Council.

The resolution was based on the understanding that the CWA does not assume responsibility for the sufficiency of design and that in most cases the benefiting community has failed to realize this situation and has not furnished engineering services where safety and protection of life are involved.

Missouri Planning Commission Named by State Governor

Governor Guy B. Parks of Missouri has appointed the Missouri Planning Commission to cooperate with the National Planning Board recently set up by the Public Works Administration in the development of plans for state and regional work. Professor R. W. Selvidge of the University of Missouri is chairman. The membership includes E. J. Russell, president of the St. Louis Regional Planning Agency, E. M. Stayton, consulting engineer, Kansas City; H. A. Buehler, state geologist; Herbert Bosch, sanitary engineer for the State Board of Health; T. H. Cutler, state highway engineer; A. P. Greenfelder, chairman of the St. Louis County Plant Commission; Professor A. S. Langsdorf, Washington University; Dean F. B. Mumford of Missouri College of Agriculture; and J. C. Nichols of Kansas City.

The St. Louis Regional Planning Agency, of which E. J. Russell is president, was organized recently and expects to employ 150 people in a survey of current trends in regional development in the St. Louis metropolitan district. The work is to be directed by Harland Bartholomew, engineer of the City Plan Commission, as director of the survey. Work is expected to cost between $150,000 and $225,000. Aid from the fund set aside by the Public Works Administration for planning work is expected.

W. S. Lee Dies; Long Prominent in Hydro-Electric Power Works

William S. Lee, president of the W. S. Lee Engineering Corp., for many years a prominent figure in hydro-electric power development, died of cerebral hemorrhage on March 24 at his home in Charlotte, N. C. Mr. Lee was 62 years old. He had been at his office as usual on March 23.

Mr. Lee was born in Lancaster, S. C., and graduated from the South Carolina Military Academy (now the Citadel) in 1894. After graduation he devoted some time to teaching and subsequently was in railway work and on water power surveys and construction. In 1900 Mr. Lee became resident engineer of the Columbus Power Co., Columbus, Ga., and two years later became chief engineer. His success there attracted the attention of J. B. Duke, then interested in the development of power on the Catawba River in South Carolina, and Mr. Duke engaged him as chief engineer of the Catawba Power Co. The close association with Mr. Duke begun at that time continued until the time of Mr. Duke's death and resulted in the naming of Mr. Lee as one of the trustees of the Duke Foundation. It resulted also in Mr. Lee's being responsible for the design and construction of the Duke power system of 32 hydro-electric and 7 steam stations and in his having a large part in the design and construction of the Duke-Price power system in Canada.

William S. Lee

During the development of the Duke power system Mr. Lee devoted the major part of his time to power work in the Carolinas, becoming an executive officer of many of the power companies of the region. He also was active in the construction and operation of the Piedmont & Northern Ry.

As the Duke power system passed from the development to the operating stage Mr. Lee began to give much of his attention to the development of the Duke-Price power resources in Canada, notably the Isle Maligne plant and the Chute-a-Caron project of the Alcoa Power Co., both on the Saguenay River in Quebec. Mr. Lee also served as one of the consultants on the Beauharnois power project on the St. Lawrence River.

W. S. Lee served as president of the American Institute of Electrical Engineers, 1930-31, also as president of American Engineering Council last year.

Illinois Sanitary Board Orders Start on Two Sewage Plants

Notice to begin construction of sewage treatment plants by January, 1935, has been served on the cities of Lincoln and Belleville by the Illinois Sanitary Water Board. The order is mandatory, but appeal can be taken to court. The proposed works are estimated to cost $280,000 at Belleville and about $150,000 at Lincoln. Action of the board followed a hearing which produced evidence showing that sewage wastes from the two cities were resulting in extensive stream pollution along Richland Creek.

PWA-RFC Combine Proposed

(Continued from p. 424)

rangement that would now be assumed by the RFC.

Estimates put the total which RFC may use to purchase the bonds of "solvent" cities at $500,000,000 although Jesse Jones, chairman, says he has no idea how large the figure would be. The RFC has been authorized by Congress to expand its operations by $850,000,000 in the fiscal year commencing July 1, but it has been requested by President Roosevelt not to spend more than $500,000,000 without first consulting him. The commitments of the RFC in the current fiscal year total $3,900,000,000 but there will be a shrinkage of several hundred millions. Repayments to the RFC on outstanding loans are coming in at the rate of $3,000,000 a day, so it appears that funds will be available in considerable volume if the plan is adopted.

As explained by Mr. Jones, the plan has merit in making public works money go as far as possible. It is not a scheme to bolster up municipal finances to make them eligible as applicants for PWA funds. Participation by the RFC does not presage either a more liberal lending policy or greater speed in the approval of local projects. The RFC probably would adhere temporarily to the 4 per cent interest basis adopted by PWA but, according to Mr. Jones, it wants the right to do its own rate-fixing.

Cities and counties are regarded by Mr. Jones as desirable if their condition is sound. The real trouble at present, as he sees it, is not the financial condition of municipalities, in most cases, but their reluctance to sell their bonds at the present market. Mr. Jones expressed the opinion that the RFC would not want to go into "districts." He did not define this term but his statement indicates that the RFC would not consider applications from as wide a variety of "public bodies" as has the PWA which has loaned its funds to sanitary, school and irrigation districts. RFC financing apparently would have one advantage not shared by PWA as proceeds from the sale of bonds purchased against construction projects would build up a revolving fund available for further loans. Proceeds from the sale of bonds purchased by PWA revert to the U. S. Treasury.

Both Mr. Jones and PWA Administrator Ickes discussed the proposal with the President before his departure for Florida. Mr. Jones cannot say definitely whether the board will favor the plan. Legislation is necessary and the next step depends on whether the RFC will recommend it to Congress.

Sewage Chlorination is Discussed at New Jersey Sewage Works Meeting

THAT CHLORINATION of sewage to a degree less than that required to satisfy completely the chlorine demand is effective in reducing the number of bacteria, has been demonstrated by the experiments conducted during the past year by the New Jersey Agricultural Experiment Station, according to the report of Dr. Willem Rudolfs at the annual meeting of the New Jersey State Sewage Works Association at Trenton, N. J., March 22 and 23. Dr. Rudolfs reported that his experiments showed that a chlorine dose sufficient to satisfy but 40 per cent of the chlorine demand of the sewage would reduce the B. Coli content by 58.6 per cent, with a contact time of 7½ minutes. At that same contact time, a 60 per cent satisfaction of the chlorine demand resulted in a B. Coli reduction of 83.5 per cent.

Not only does the kill of bacteria vary with the degree of satisfaction of the sewage's chlorine demand, but it also increases with the time of contact, the experiments indicate. Bacterial reductions greater than those cited in the foregoing paragraph will be obtained with greater contact time. For example, a 100 per cent kill can be obtained with but 40 per cent satisfaction of chlorine demand if the contact time is 30 minutes. The apparent selectivity of chlorine for bacteria as against other organic matter in the sewage can be partly explained on the ground that the three types of organic matter have varying affinities for chlorine, according to Dr. Rudolfs. Proteins have a greater chlorine demand than do either carbohydrates or fats.

Atmospheric pollution

Another subject given close attention at the meeting was atmospheric contamination by sewage works, which was discussed by Prof. Gordon Fair in a paper written jointly by him and William F. Wells. In this paper, atmospheric pollution from sewage plants was stated to be of three kinds: odors, bacteria and insects. The first two types formed the subject of the discussion.

By means of the devices developed at the Harvard Engineering School during the past year for the measurement of odor intensities, measurements were made of the odors of the atmosphere directly above the various treatment units at an activated sludge plant, and were expressed in terms of the pO scale. This scale is built in terms of the number of dilutions necessary to reduce the odor to its threshold intensity, and is expressed as the exponent of 2. The observations showed that the atmosphere above the raw sewage at the plant under observation had an odor intensity of 5, indicating a 32 to 1 dilution necessary to reduce the odor to its threshold intensity. The odor above the activated-sludge tank had a pO of 3, and that of the return sludge had a pO of 1. Odor intensities up to pO 6 were observed above intermittent sand filters. Much higher odor intensities were noted in connection with sludge digestion.

Preliminary findings only were presented of the study on bacterial pollution of the air. The mechanics of atmospheric pollution with bacteria were explained as follows: droplets of sewage are injected into the atmosphere by spray nozzles, aeration tanks or other turbulence; the droplets evaporate before settling again into the body of the sewage; the solid residue is in the form of a minute particle bearing bacteria upon it. The seriousness of such contamination depends upon the viability of the organisms involved.

Comments on the operation of activated sludge plants were presented by S. Vermilye, of Tenafly, N. J. Mr. Vermilye gave as his opinion that many chemical tests made in routine laboratory work at sewage plants are both inaccurate and of limited value, particularly for control purposes. At Tenafly, the concentration of solids in the aeration tank liquid is made with a centrifuge, which was claimed to give a better indication of the settleability of the material than any other test. Mr. Vermilye referred to the activated sludge process as a return to the "natural" process of sewage purification, drawing an analogy between the treatment methods in use at Tenafly and the purification of sewage in a natural flowing stream.

C. G. Wigley, of Atlantic City, spoke of the value of sludge as a fertilizer. He stated that the fertilizing value of the material was greater than that indicated by chemical analysis. However, for best results, it should be supplemented by other mineral salts.

Contract With PWA Signed By Muskingum District

Directors of the Muskingum Watershed Conservancy District in Ohio last week signed a contract with the federal PWA for the $34,000,000 Muskingum flood control project. The form of the contract for the advance of $22,590,000 of PWA funds was approved on March 5 by the conservancy court.

The legislature will be asked by Governor White to appropriate $2,000,000. An additional $4,000,000 will be obtained from the highway department and $6,000,000 will be raised in the district itself.

SOCIETY CALENDAR

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Vancouver, B. C., Canada, July 11-14.

AMERICAN WATER WORKS ASSOCIATION, annual convention, New York, June 4-8, 1934.

AMERICAN WELDING SOCIETY, annual meeting, New York, April 26.

INTERNATIONAL CITY MANAGERS' ASSOCIATION, annual conference, St. Louis, Oct. 15-17.

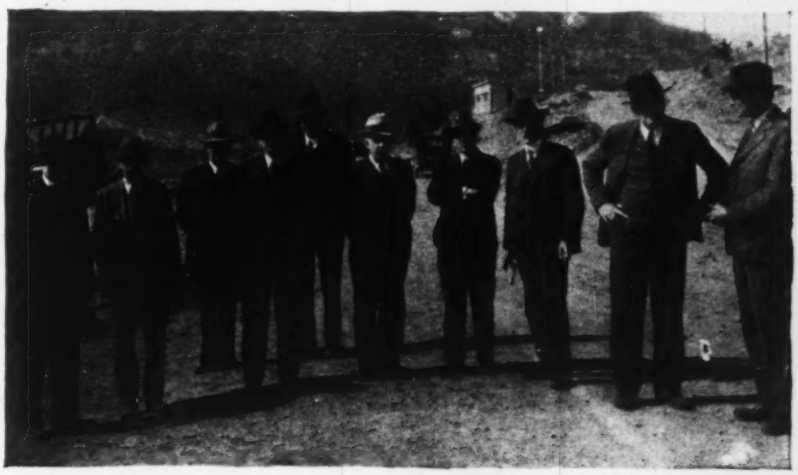
SMOKE PREVENTION ASSOCIATION, annual convention, June 19-22, Buffalo, N. Y.

INDIANA SECTION, American Waterworks Association, Lafayette, Ind., April 11-13.

FOUR STATES SECTION, American Water Works Association held its annual convention at Philadelphia, Pa., on March 7-8. A paper on progress in zeolite softening was presented by A. S. Behrman; the difficulties resulting from improper main flushing were described by M. H. Coblenz; the taste and odor problem at Chester, Pa., was outlined by Rennie I. Dodd; booster stations were discussed by Frank M. Winder; laboratory equipment at New York University was described by Thomas M. Riddick. Harry R. Hall was elected chairman of the section for the ensuing year.

ENGINEERING BOARD VISITS SITE OF NORRIS DAM

Foundation conditions at Norris Dam on the Clinch River and at General Joe Wheeler Dam on the Tennessee as well as the structural designs and construction layout, were the subject of critical study by a board of engineers March 15-17. The accompanying photograph, taken at Norris Dam, shows, left to right: L. F. Harza, consulting engineer, Chicago; C. A. Bock, director of engineering for TVA; J. L. Savage, chief designing engineer, U. S. Bureau of Reclamation, Denver, Colo.; S. M. Woodward, professor of mechanics and hydraulics, University of Iowa; Ross White, construction superintendent for TVA; C. H. Paul, consulting engineer, Dayton, Ohio; F. W. Scheidenhelm, consulting engineer, New York; C. P. Berkey, geologist, New York; Barton M. Jones, construction engineer for TVA; and A. E. Morgan, chairman of the board of the Tennessee Valley Authority.



Personals

M. B. CASE has become associated with Ralph Modjeski and Frank M. Masters, under the new firm name of Modjeski, Masters and Case, Inc.

JAMES B. HAYS, after eight years with the Aluminum Company of America, on hydroelectric construction in Tennessee and North Carolina, is now with the U. S. Bureau of Reclamation in charge of grouting operations on dams built by the Bureau.

R. H. DEARBORN, formerly head of the Electrical Engineering Department, Oregon State College, Corvallis, has been appointed acting dean of the School of Engineering, following the resignation of former Dean H. S. ROGERS, who left at the beginning of the school year to become president of Brooklyn Polytechnic Institute, New York.

CHARLES B. SMITH, bureau of reclamation, office engineer on the Grand Coulee Project, Almira, Wash., has been named senior engineer for the U. S. Army Engineers' office in Seattle. Mr. Smith prepared a report for the War Department in 1932 on the irrigation possibilities of the Columbia Basin project.

R. C. E. WEBER, superintendent, Orland Project, Calif., U. S. Bureau of Reclamation for 25 years has been assigned to the Yuma Project as superintendent replacing R. M. PRIEST, who is assigned to the All-American Canal as construction engineer. D. L. CARMODY, who has been on the Boulder Dam project for the past three years, and prior to that on the Yakima and Riverton projects, succeeds Mr. Weber at Orland.

A. C. WILLARD, acting dean of the University of Illinois college of engineering, has been elected president of the university, succeeding H. W. Chase, who resigned last summer to become chancellor of New York University. President Willard, a graduate in mechanical engineering of Massachusetts Institute of Technology, is nationally known for his work in heating and ventilating, having served as consultant for the Holland Vehicular Tunnels, and the proposed subways for Chicago. He has been on the Illinois faculty since 1913 in the mechanical department where he has supervised numerous experiments on heating and ventilating.

Obituary

W. S. MARTIN, prominent railway official and president of the Arkansas and Memphis Railway Bridge and Terminal Co., died March 21, at the age of 70.

HARRY R. FARDWELL died at his home in San Antonio, Tex., at the age of 70 years. He was assistant chief engineer of the Louisiana Purchase Exposition (World's Fair) of 1904 during its construction period, and later served as chief engineer. He served as sewer commissioner for St. Louis from 1905 to 1911.

HURLBUT A. FORD, 44, consulting engineer, associated with Dyer Engineers, Inc., Cleveland, Ohio, for many years, died in Aurora, Ohio, March 21.

FRANK W. MCCRADY, 77, a well-known civil engineer in British Columbia, died March 14. He served as superintendent of the Victoria Electric Railway, Victoria, B. C., for several years.

THOMAS J. FLYNN, retired engineer, at one time superintendent of construction on a number of projects in the vicinity of New York City, died March 20 at his home in Niagara Falls, N. Y.

CONSTRUCTION STATISTICS OF THE WEEK

THIS WEEK'S ENGINEERING contracts at $29,200,000 bring the first quarter total up to $303,046,000 or about 42 per cent ahead on dollar volume of the same period last year. Both public and private awards are higher this week, $23,856,000 for the former and $5,344,000 for the latter. Federal work is lower, however, the second lowest week of the year, $2,844,000, while state and municipal awards at $21,012,000 register the highest week of this year.

Streets and roads are up, $6,108,000, compared with $5,563,000 last week; waterworks contracts are high, $1,961,000 compared with $506,000 last week; sewerage awards score the high week for this year, $2,320,000; bridges are up to $3,217,000 but the large gains in both public and private are in the "unclassified" work including railroad work and the mid-town tunnel, New York.

Large projects include: highway lettings, by Texas, $814,000; by Indiana, $986,000; water pressure conduit, St. Louis, $1,013,000; two contracts, numbers 7 and 8, by Sanitary District of Chicago for West Side intercepting sewer, $953,000 and $772,000; bridge lettings by state highway department of Illinois, $529,000 and of Florida, $1,116,000; earthwork, tunnels and structures for the Casper-Alcova project, Wyoming, $640,000; Mid-town tunnel between Weehawken, N. J., and New York City, $6,452,000; and rail contracts and railway maintenance by force account, $720,000 by Chicago, Milwaukee and St. Paul R.R., and $1,672,000 by St. Louis and San Francisco Railroad.

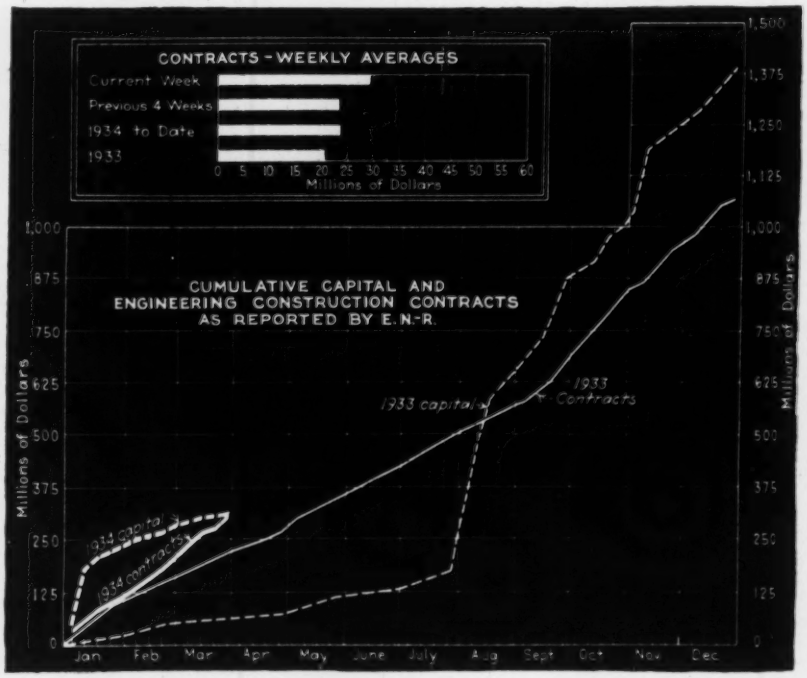
New productive capital this week is higher both for PWA allotments and state and municipal bond sales. The municipal bond market continues strong and is absorbing a large volume of funding and refunding issues.

CONTRACTS
(Thousands of Dollars)

	Weekly Average Week Mar. 1933	Pre.4 Weeks	Mar.29 1934
Federal Government	$2,538	$4,289	$2,844
State and municipal	4,373	11,513	21,012
Total public	$6,912	$15,802	$23,856
Total private	4,675	7,449	5,344
Week's total	$11,587	$23,251	$29,200
Cumulative to date: 1933	$213,839	1934	$303,046

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1934	Week Mar.29	Cumulative
State and municipal	$2,948	$55,355
PWA allotments, S&M	3,029	197,925
Corporate issues		10,595
PWA allotments, private	250	44,831
Total, Non-Federal	$6,227	$308,706
PWA allotments Federal Constr.		48,102
Total new capital	$6,227	$356,808
Cumulative to date: 1933	$68,406	1934 $308,706
Rescinded or reduced allotments (from 1933 PWA totals)		$43,323

INDEX NUMBER

E.N.-R.-Cost		E.N.-R.-Volume	
March, 1934	**194.04**	**February, 1934**	**88**
February, 1934	194.04	January, 1934	113
March, 1933	158.44	February, 1933	82
1933 (Average)	170.18	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1913 (Average)	100